NORTH AMERICAN CESTODES OF THE ORDER PSEUDOPHYLLIDEA PARASITIC IN MARINE AND FRESH WATER FISHES

BY

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INTRODUCTION

Soon after commencing the study of Haplobothrium globuliforme Cooper (1914 a and b) the writer saw that, apart from the early and somewhat brief reports and descriptions by Leidy and the later, but yet pioneer work of Linton on both marine and freshwater species, very little had been done on the members of the order in America. Consequently the desire for an opportunity to work up other species which had in the meantime been collected at the Canadian Lake Biological Station on Georgian Bay, located at Go-Home-Bay, Muskoka District, Ontario, and at the Marine Biological Station at St. Andrews, New Brunswick, grew with the feeling that something of a comprehensive nature ought to be undertaken in order not only to ascertain to what extent European species are to be found in this continent but also to properly locate in the classification at least some of the new forms formerly described especially by Linton. Altho the material then at hand was investigated to a certain extent at the University of Toronto, it was not until the writer came to the University of Illinois that it was studied at all thoroughly with the aid of other material from the collection of the University of Illinois, under the care of Professor Henry B. Ward, for comparison.

Supplementary material, which in many cases was all that was available, was obtained by Dr. Ward from the United States National Museum and the Bureau of Animal Industry, but apart from a few vials no European specimens could be procured owing to the present international conflict. On account of the lack of the latter most of the determinations have been made with the aid of

the literature only, a fact which the writer feels may necessitate future changes in connnection with a few species which have been more or less tentatively regarded to be the same as those in Europe. In all cases, however, the specific details of the American forms have been emphasized so that if changes have to be made later, the basis for such will be at hand. The writer would like to point out in this connection the comparative lack from a systematic standpoint of adequate descriptions of many of the European species which have been known for many years. It was this fact which in the absence of the original material for comparison made the present work one attended with not a little difficulty.

In the main the classification of the order adopted by the writer is that proposed by Luehe in 1902 in his "Revision meines Bothriocephalidensystemes" and later (1910) retained in "Die Süsswasserfauna Deutschlands" with only a few modifications. The family of the Caryophyllaeidae is, however, not included, so that the order is considered to be rather that of Carus (1863), with, of course, Luehe's later conceptions of the other families. One of the latter has now again got to be modified considerably owing to the present study of two quite aberrant species, viz., Haplobothrium globuliforme Cooper and Marsipometra hastata (Linton) which have been found by the writer to be very disturbing to the classification, the former, in fact, possessing a scolex which bears strong resemblance to that of the order Trypanorhyncha.

The writer wishes to here tender his thanks in the first place to the Biological Board of Canada for placing means and facilities at his disposal in connection with his earlier collecting at the above mentioned Canadian Biological Stations; to the

University of Illinois for the opportunity of collecting further material at the Marine Biological Laboratory at Woods Hole, Massachusetts, and at the Harpswell Laboratory, South Harpswell, Maine, during the summer of 1916, and to the staffs of these institutions as well as to that of the Marine Laboratory of the United States Bureau of Fisheries at Woods Hole for assistance and direction in connection with the same; to the Smithsonian Institute and the Bureau of Animal Industry, from whom valuable material was obtained for comparison, in the latter case thru the kind offices of Dr. C. W. Stiles of the Hygienic Laboratory, Washington; and to the following investigators for alcoholic specimens: Professor O. Fuhrmann, University of Neûchatel, Professor Edwin Linton, Washington and Jefferson College, Professor E. M. Walker, University of Toronto, Dr. H. J. Van Cleave, University of Illinois, Mr. H. R. Hill and Mr. R. P. Wodehouse.

Finally to Professor H. B. Ward the writer wishes to express his sincere indebtedness not only for the use of his extensive private library and collections and for his procuring rare books and specimens, but for his constant and stimulative interest in and valuable criticism of the work which has resulted in the following paper.

HISTORICAL DATA

Apart from Gmelin's (1790) collecting together the data given by the older writers such as Linnaeus, Pallas, Mueller, Goeze, Bloch, Fabricius, Batsch, Schrank, and Abildgaard and Zeder's (1880 and 1803) treatises, the first most important work on the bothriocephalid cestodes was the "Entozoorum Historia Naturalis" by Rudolphi (1808-1810). In this he reviewed the earlier literature, making valuable comments on the same, and described species of Ligula, Triaenophorus and Bothriocephalus, the latter name being used for the first time. While Lamarck (1816) dealt with only the more common species, Rudolphi in his second work of major importance, the "Entozoorum Synopsis" (1819), made some corrections of his earlier publication and further contributions in the way of a few new species. Leuckart (1819), who did not receive Rudolphi's "Entozoorum" until after his work was in print, dealt only with species of the genus Bothriocephalus as conceived by Rudolphi, which then contained members not only of the Pseudophyllidea but also of the Tetraphyllidea and the Trypanorhyncha. Nitzsch (1824) briefly defined the species of the same genus, while later in the same publication Creplin (1839) dealt with them more in detail and erected the new genus Schistocephalus. Drummond (1838) was one of the first to report bothriocephalids from the British Isles, while Bellingham (1844) and Thompson (1844) made further contributions, all three dealing with forms from Ireland. Eschricht (1841) published some of the earliest data on the internal anatomy of the group, and Koelliker (1843) made a study of the development of the eggs of a few species. The next and perhaps

most important work was that by Dujardin (1845) who, while following Rudolphi in the main, made many valuable additions from original observations. Van Beneden (1849 and 1850) first essayed to erect a more comprehensive classification than had hitherto been used, and Diesing (1850) went much farther in his Subtribe I, Gymnobothria, of Tribe IV, Bothriocephalidea, of Suborder I, Aprocta, of Order IV Cephalocotylea. Baird (1853) reverted to Rudolphi's brief system in listing forms from the British Museum. Wagener in two papers (1854 and 1857) gave studies on the development which even today are models of careful work and excellent illustrating. Leidy (1855 and 1856) was the first to report forms from America, while Weinland (1858) in his "Essay" made a few references to bothriocephalids. Then, until Diesing (1863) revised his classification nothing of systematic importance was published. Olsson (1867) was one of the first to report species from the Scandinavian countries; later (1876 and 1893) he made further contributions from the same source. After Willemoes-Suhm's (1869) studies on the development of Sch. dimorphus, came Duchamp's (1876) and Donnadieu's (1877) classical experiments on the life-histories of the Ligules. In his Compendium von Linstow (1878) brought together in a list the forms known up to that time. A few years later Fraipont (1880, 1881) published studies on the excretory system of a number of species which even to-day are perhaps the most important contributions in that direction. The nervous system was made the object of special inquiry by Lang (1881), while later it was dealt with more at length by Niemiec (1888) and Cohn (1898). After a period in which such works as Moniez's (1881) "Memoire", Zschokke's (1884) researches, and Schauinsland's (1885) studies of

the embryonal development are prominent, we arrive at the second reports of species from America, namely, those contained in Linton's (1889) first paper. This was followed by a second (1890), containing extensions of the first, and much later by others (1891, 1897, 1901 and 1901a) dealing with a variety of forms from marine and fresh-water fishes. Further anatomical studies by Loennberg (1891), Kraemer (1892), Matz (1892) and Zernecke (1895) lead us on to Monticelli's (1892) classification, which was the most important since the time of Diesing, altho Perrier (1878) had in the meantime published his ideas along that line. The next in order is Ariola(s (1896) division of the family "Bothriocephalidae", in which incidentally were yet to be found errors regarding the position of the bothria. Beginning with 1894 and continuing to 1900 there was in progress the publication of Braun's "Cestodes" in Bronn's "Thierreich", which is by far the most important work on the group since it brings together in a comprehensive manner the substance of the most important of the earlier works on the morphology as well as the system of the group. One of the first papers by the late Dr. Luehe, who was the leading authority on the group was that (1896) in which he dealt with the nervious system of Ligula. Further study led him to publish a few years later (1899) his first classification, which was adopted by Braun (1894-1900). In the meantime Lönnberg (1897) made important contributions to the knowledge of the phylogeny of the parasitic flatworms; while Gamble (1896) in the "Cambridge Natural History" and Perrier (1897) had erected systems of classification which, however, do not have nearly as much in their favor for general acceptance as does that

by Luehe. In 1900 Ariola brought out his revision of the family of the Bothriocephalidae, which, however, was shown by Luehe (Ariola, 1901) to be rather of the nature of a compilation, involving at the same time several omissions, than a distinct advance in our knowledge. Then in 1901 there appeared in Lankester's "Treatise on Zoology" Benham's classification of Cestodes which professedly follows the earlier works of Railliet and Blanchard. Luehe's (1902a) revision of the bothriocephalid system comes next in order. It is this newer system, only slightly modified in 1910, that is accepted by the writer with several necessary modifications which are dealt with below.

From 1902 until "Die Süsswasserfauna Deutschlands" was published the literature on the group consists mostly of papers on individual species or mere listings. Spengel's (1905) paper on "Die Monozootie der Cestoden" ought, however, to be mentioned, since it is one of the latest discussions of a question which occupied a good deal of the attention of many of the older writers. Finally Ward (1910) and the writer (1914 a and b) made the latest additions to the American literature, while Stiles and Hassall (1912) won the gratitude of the younger workers at least by their publication of the section of the "Index-Catalogue of Medical and Veterinary Zoology" on "Subjects: Cestoda and Cestodaria" which the writer has found of inestimable value in the pursuit of his studies.

EXPLANATION OF TERMS

Owing to not a little confusion which exists in the earliest literature regarding the terms of orientation used for the cestode body, the writer wishes to here explain those that will be employed in the specific descriptions below. Even much later than the time of Diesing (1850) the word "lateral" referred to the flat surface of the strobila, while "marginal" was and is even yet perfectly clear; but from the standpoint of bilateral symmetry both words may mean the same thing. Here they are considered to be synonymous and are used to refer to any part that is situated in, at or towards the edges of the strobila. On the other hand, the work "surficial" is introduced from geology to take the place of the German word "flächenständig" which is used freely in Luehe's papers to mean that the structures in question are situated on the broad, flat surfaces of the chain, that is, its dorsoventral faces. The end bearing the scolex is called the anterior end and the opposite the posterior, as is customary, despite controversies regarding which is which. For the sake of brevity the words, "length", "depth" and "breadth" (or "width") are used instead of the longer terms, diameters in the longitudinal, in the dorsoventral and in the transverse directions, respectively, excepting where the organ in question, e.g., the transversely elongated cirrus-sac of the Triaenophorinae is so shaped that it would be confusing to speak of its obvious length as its width. Otherwise the usual terms of orientiation are employed.

Order PSEUDOPHYLLIDEA Carus 1863, nec Luehe 1910, e.p.

Polyzootic, Cestodes with mostly unarmed, seldom armed, scolex without rostellum, or proboscis formation, excepting in the Haplobothriinae where the primary scolex is provided with four protusible proboscides resembling those of the Trypanorhyncha; usually with two weakly developed sucking grooves, which in individual cases are modified by the strong development of their walls or by more or less extensive fusion of their edges, so that they may appear funnel-shaped or tubular, which may also unite with each other more or less completely to form an unpaired terminal adhesive organ, become rudimentary or entirely absent, in which latter case they are likewise replaced by a termainal functional organ of attachment. Furthermore the development of a pseudoscolex takes place occasionally. Head stalk absent. External segmentation more or less pronounced, only seldom completely absent. Genitalia in each segment usually single, seldom double. Their development proceeds from ahead backwards and does not continue to a degeneration of the reproductive glands, but the majority of the proglottides, being at the same stage of development, bring their sexual products to maturity at the same time, so that in all of them new eggs are formed continuously and all the eggs of the whole animal are at the same stage of embryonic development. A surficial opening of the uterus is always present.

Testes numerous, vas deferens strongly coiled without a true seminal vesicle. Ovary near the posterior end of the proglottis, mostly median in the case of single genitalia, seldom approaching the margin of the strobila bearing the genital opening

(that of the cirrus and vagina). Vitelline follicles very numerous, mostly in the cortical, seldom in the medullary parenchyna. Uterus, a more or less winding canal, the individual coils of which converge somewhat towards the centre of the proglottis to form the so-called rosette; but in other forms it enlarges to a capacious cavity, the uterus sac, from which the duct-like beginning of the uterus is sharply separated. Eggs operculate or non-operculate, developing mostly only after being laid, but in other cases within the uterus.

The above diagnosis of the order is that of Luehe (1910: 11-12) minus the family Caryophyllaeidae and partly emended to accommodate the subfamily Haplobothriinae in which what the writer considers (vide infra) to be the true (or primary) scolex is deprived of bothria but provided with four eversible probosoides quite comparable in structure to those of the order Trypanorhyncha. As to the phylogenetic significance of these organs which are quite unique for bothriocephalids, the writer is not yet in a position to make any definite statements, since the earliest stages in their development have not been observed. It is evident that we can not now consider what was formerly (Cooper, 1914 a and 1914 b) called the scolex of Haplobothrium to be a true scolex but only the foremost segment of the adult or secondary strobila, which was indeed foreshadowed by the writer by his emphasis of its resemblance internally as well as externally to the segments immediately following. Whether or not a pair of bothria were originally present or are present in the very earliest stages, whether such bothria have become modified into the probosoides, or whether the latter have

developed from four separate "accessory suckers" (vide infra, p.), as believed by Pintner (1880) to be the case in the Trypanorhyncha, must remain mere suggestions for the present. Furthermore, as to the formation of segments we have in Haplobothrium not only conditions quite similar to those in Bothriocephalus s.str. and other genera in which there is no neck but segmentation begins immediately behind the scolex, but those reminding us of the proliferation of scolices in echinococcus. In the former case we shall see below where the process is described more in detail (p.), that a primary segment divides up into secondary segments, these into tertiary segments, and soon until there may be eventually 32 or more genital segments corresponding to one primary segment formed immediately behind the scolex. In Haplobothrium a primary strobila divides up into primary segments, these subdivide into secondary segments, the definitive joints of the ordinary strobila met with, which in turn may subdivided again and evidently indefinitely to form new chains. The chief difference between these two cases is one of degree of regularity in the subdividion. Whereas in Bothriocephalus the whole anterior region of the worm is affected, evidantly no division taking place after the rudiments of the reproductive organs have become separate from the common rudiment, and the subsegments remain attached to one another, in Haplobothrium not only do the primary segments separated as secondary strobilas, but in the latter only a limited region is involved in further subdivision. On the other hand there is somewhat of a resemblance between this manner of subdivision in Haplobothrium and that of the larval Echinococcifer in that the

strobilas are developed from an original "nurse". That is, we might look upon the primary strobila of the former as a nurse from which are developed segments, comparable to the daughter-cysts of an echinococcus, which in turn produce (secondary) scolices and eventually strobilas. In other words we might recognize at first sight a sort of alternation of generations in the case of Haplobothrium. But this comparison is only a superficial one, for as will be shown below (under Haplobothriinae) the secondary scolex cannot be considered to be a true scolex nor the secondary strobila a true strobila; but the primary strobila with its four proboscides must be regarded as such. Finally, this peculiar method of segmentation reminds one of the asexual budding of some of the oligochaete worms, particularly as regards the proliferation of subsegments in the anterior region of the first formed divisions; but further than this the comparison can scarcely be carried.

Family I. DIPHYLLOBOTHRIIDAE, Luehe 1910, char. emend.

Polyzootic Pseudophyllidea with unarmed or (seldom) armed scolex. Surficial bothia variously developed; they may be modified to form sucking tubes, each with an anterior and a posterior opening, thru the growth together of their free edges, while an unpaired terminal organ of attachment can serve as a funcational substitute for the rudimentary bothia or result from the more or less complete fusion of both bothria. The whole scolex may be replaced in sexually mature specimens by a pseudoscolex; or it may be (Haplobothriinae) provided with four protrusible proboscides.

Neck present or absent. External segmentation mostly present, seldom absent. Genital organs numerous, mostly single in each proglottis, seldom double. Cirrus unarmed, excepting in Haplobothrium, with cleft cuticula. Opening of cirrus and vagina surficial or marginal, in the first case always on the same surface as the uterus opening and ahead of this as well as always in the median line of the genital complex, also in the median line of the proglottis in the case of single genitalia. Both surfaces of the chain of proglottides, apart from the genital openings, similarly shaped. Receptaculum seminis formed by a local enlargement of the vagina near its inner end, which as a rule is sharply separated from the spermi-duct (terminal portion of the vagina). Uterus, a long more or less winding canal, usually in the form of a rosette, arising from almost transversely directed coils crossing the median line. It may be locally more or less enlarged, but seldom forms an undivided uterus-sac distinct from the uterine duct, as in the Ptychobothriidae. Eggs thick shelled, with opercula, excepting in the Marsipometrinae; their formation is carried on continuously in fully-developed proglottides; embryonal development usually after liberation, seldom in the uterus, in which, however, one finds all stages side by side.

Parasites of vertebrates.

Luehe's (1910: 16-17) diagnosis is here emended to include the new subfamilies Haplobothriinae and Marsipometrinae. In the former not only is the scolex radically different from that of any other member of the family, but the cirrus is armed with minute spines and there is a distinct uterus-sac separate from

the uterine duct as in the Ptychobothriidae; while in the latter there is likewise a uterus-sac and the eggs are not provided with opercula. The scolex of Haplobothrium is discussed above under the order and more at length below under the species so that no further mention of it is necessary at this point. The cirrus, however, would seem to exclude the genus from the family Ptychobothriidae as well as from the Diphyllobothriidae, since it is not "unbestachelt, mit zerklüfteter cuticula", but provided with minute yet distinct cuticular spines bearing some resemblance to those of the Acanthophallidae (= Amphitretidae) as pointed out elsewhere by the writer (1914 a : 3). But H. globuliforme is otherwise so nearly related to D. latum that it does not seem wise to remove it from the family on this account, especially since these spines are so minute and since the evidence points to their being probably of little, if any, functional importance. As regards the uterus, on the other hand, we have something which is quite different from that of any of the members of this family in that it is distinctly divided into uterine duct and uterus-sac as in the Ptychobothriidae. It is true that in the genus Scyphocephalus one or two of the coils of the uterine rosette becomes much enlarged when the organ is filled with eggs, while in Bothridium, as stated by Luehe (1899 : 49), "Der Uterus bildet keine Rosettenform, lässt jedoch Uteringang and Uterus s.str. deutlich unterscheiden; letzterer stellt gewissenmassen eine zweitheilige Uterushöhle dar, indem zwei hinter einander gelegene grosse Hohlräume durch einen kurzen und dünnen Canal miteinander in Verbindung stehen"; but in neither case is there a single

uterus-sac, distinct and separate from the uterine duct or beginning of the uterus but only a modified rosette formation. Roboz (1882 : 282) in describing the development of the uterus of Bothridium pithonis said that: "In dieser Weise ist er natürlich nur in jüngeren Gliedern entwickelt, während er dort, wo die Befruchtung schon beendet ist, in Folge der immer stärkeren Ansammlung von den mit chitinöser Hülle umgebener Eiern immer grösser wird und sich schliesslich zu einem die ganze Mittelschicht ausfüllenden Sack ausbreitet." It would thus seem to be comparable to that of the Ptychobothriidae in that its functional sac is developed by a distal enlargement of the original duct, which gradually encroaches upon the medulla (vide infra), but evidently there is no separation of the organ into two distinct parts at any stage as there is in Haplobothrium. And, as emphasized elsewhere by the writer (1914a : 2-3), this separation is present at all stages in the development of the organ, which as a matter of fact proceeds in quite the same manner as that of Bothriocephalus. In Marsipometra, on the other hand, even tho the sac is formed in the same way, it is never very sharply separated from the uterine duct, altho such appears to be the case in the adult. Reference to the specific description below will elucidate this latter point which seems somewhat paradoxical. Finally, as regards the fact that its eggs are not provided with opercula, Marsipometra stands alone. This character would place it at once in the Ptychobothriidae, but it is otherwise so closely related to the subfamily Triaenophorinae, that the writer here amends the family to accommodate it. Thus we see that these two

isolated genera have such a disturbing influence on our conceptions of the two families that the latter now seem to be much more closely related than was formerly thought to be the case.

Subfamily 1. Ligulinae, Luehe 1899

Scolex unarmed, very short, almost triangular, with anterior end, more or less drawn out into a point according to the state of contraction, passing directly into the chain of proglottides or the similarly shaped unjointed body; surficial bothria small, weakly developed. Neck absent. Formation of proglottides complete, confined to the anterior end or (in young animals) absent. Posterior end rounded. Nervous system distinguished by a large number of plexus forming longitudinal nerves near both chief strands. Genital organs in sexually mature individuals completely developed close behind the scolex. Genital openings surficial, ventral, lying behind or near one another, near the median line. Testes in a simple dorsal layer in the lateral fields of the medullary parenchyma, for the most part lateral to the nerve strands. Ovary and shell-gland median, the former ventral, the latter dorsal. Vitelline follicles in the form of a mantle in the lateral fields of the cortical parenchyma. Vas deferens enlarged to a muscular bulb before entering the cirrus-sac. Receptaculum seminis large, sharply separated from the short and narrow spermiduct.

Sexually mature in the intestines of water birds; present as larvae in the body-cavities of teleosts where they grow quite large and form the rudiments of the reproductive organs; occasion-

ally also observed free in the water which they reach evidently by the rupture of the greatly distended bodywall of the intermediate host.

Type genus: *Ligula* Bloch.

In the above diagnosis of the subfamily by Luehe (1910: 17-18) the statement that the testes are "in einfacher dorsaler Schicht den Seitenfeldern des markparenchyms grossentheils lateralwärts von den Marksträngen" is somewhat confusing, for it is strictly correct only when the whole number of testes is taken into consideration. In transections of both *Ligula* and *Schistocephalus* the nerve strand was actually found by the writer to be more than halfway from the median line to the margin of the medulla, but the testes were much more closely crowded in the lateral portion of the field, hence making their total number there more than in the median field. But the differences between the two fields on each side in this regard were seen in confirmatory frontal sections to be much greater in *Ligula* than in *Schistocephalus*.

Genus 1 *Ligula* Bloch, 1782.

Taenia (part.)	Auctorum
Fasciola (part.)	Linnaeus, 1758.
Fasciola (part.)	Linnaeus, 1767.
Ligula	Bloch, 1782.
Fasciola (part.)	Goeze, 1782.
Bothriocephalus (part.)	Nitzsch, 1824.
Ligula	Creplin, 1839.
Dibothrium (part.)	Donnadieu, 1877.

Generic diagnosis: Bothria as well as external segmentation completely absent from the larvae, both develop simultaneously with the maturation of the sex-organs in the definitive host, and then the external segmentation, which does not correspond with the internal, is confined to the anterior end. Longitudinal and transverse muscles irregularly interwoven in the anterior end, posteriorly separated into an inner transverse and an outer longitudinal layer.

Type (and only) species: <u>Ligula</u> <u>intestinalis</u> (L).

Ligula intestinalis (Linnaeus,1758)

(Figs. 1 - 6.)

Larval stage:

1713	*Taenia*	Geoffroy	1713 : 50.
1740	*Taenia capitata*	Frisch	1740 : 121.
1758	*Fasciola intestinalis*	Linnaeus	1758 : 649.
1767	*Fasciola intestinalis*	Linnaeus	1767 :1078.
1781	*Taenia cingulum*	Pallas	1781 : 95.
1782	*Ligula piscium*	Bloch	1782 : 2.
1782	*Fasciola abdominalis*	Goeze	1782 : 187.
1790	*Ligula abdominalis*	Gmelin	1790 :3043.
1790	*Ligula a. cobitidis*	Gmelin	1790 :3043.
1790	*Ligula a.cyprinorum*	Gmelin	1790 :3043.
1790	*Ligula a.alburni*	Gmelin	1790 :3043.
1790	*Ligula a. bramae*	Gmelin	1790 :3043.
1790	*Ligula a. carassii*	Gmelin	1790 :3043.
1790	*Ligula a. gobionis*	Gmelin	1790 :3043.
1790	*Ligula a. leuscisci*	Gmelin	1790 :3043.
1790	*Ligula a. trincae*	Gmelin	1790 :3043.
1790	*Ligula a. vimbae*	Gmelin	1790 :3043.
1790	*Ligula petromyzontis*	Schrank	1790 : 119.
1793	*Ligula salvelini*	Schrank	1793 : 143.
1802	*Ligula simplicissima*	Rudolphi	1802 : 99.
1803	*Ligula alburni*	Zeder	1803 : 266.
1803	*Ligula bramae*	Zeder	1803 : 263.
1803	*Ligula carassii*	Zeder	1803 : 262-3.
1803	*Ligula cobitidis*	Zeder	1803 : 266.
1803	*Ligula colymbi*	Zeder	1803 : 266

1803	Ligula gobionis	Zeder	1803 : 265.
1803	Ligula leucisci	Zeder	1803 : 265.
1803	Ligula tincae	Zeder	1803 : 265.
1803	Ligula vimbae	Zeder	1803 : 265.
1810	Ligula acuminata	Rudolphi	1810 : 24.
1810	Ligula cingulum	Rudolphi	1810 : 20-22,31.
1810	Ligula constringens	Rudolphi	1810 : 22-24.
1810	Ligula contortrix	Rudolphi	1810 : 18-19.
1819	Ligula simplicissima	Rudolphi	1819 : 134.
? 1819	Ligula crispa	Rudolphi	1819: 134-35.
1819	Ligula edulis	Briganti	1819 : 209.
1839	Ligula simplicissima	Creplin	1839 : 295.
1839	Ligula monogramma	Creplin	1839 : 296.
1839	Ligula digramma	Creplin	1839 : 296.
1853	Ligula simplicissima	Baird	1853 : 95.
1855	Ligula monogramma	Leidy	1855 : 444.
1861	Ligula monogramma	Beneden	1861 : 139.
1891	Ligula catostomi	Linton	1891 : 66.
1896	Ligula monogramma	Zschokke	1896 : 773,774,775.
1897	Bibothrium ligula	Linton	1897 : 438.
1899	Ligula abdominalis	Luehe	1899 : 52.
Adult stage:			
1782	Ligula avium	Bloch	1782 : 4.
1782	Fasciola intestinalis	Goeze	1782 : 183.
1790	Ligula intestinalis	Gmelin	1790 : 3042.
1802	Ligula simplicissima	Rudolphi	1802 : 99.
1803	Ligula colymbi	Zeder	1803 : 266.
1810	Ligula uniserialis	Rudolphi	1810 : 12.

1810	*Ligula alternans*	Rudolphi	1810 : 13.
1810	*Ligula interrupta*	Rudolphi	1810 : 15.
1810	*Ligula sparsa*	Rudolphi	1810 : 16.
1819	*Ligula uniserialis*	Rudolphi	1819 : 132.
1819	*Ligula alternans*	Rudolphi	1819 : 133.
1819	*Ligula interrupta*	Rudolphi	1819 : 133.
1819	*Ligula sparsa*	Rudolphi	1819 : 133.
1824	*Bothriocephalus semi-ligula.*	Nitzsch	1824 : 98
1839	*Ligula uniserialis*	Creplin	1839 : 296.
1839	*Ligula interrupta*	Creplin	1839 : 296.
1844	*Ligula sparsa*	Bellingham	1844 : 165.
1845	*Ligula uniserialis*	Dujardin	1845 : 628.
1845	*Ligula alternans*	Dujardin	1845 : 629.
1845	*Ligula interrupta*	Dujardin	1845 : 629.
1845	*Ligula sparsa*	Dujardin	1845 : 629.
? 1845	*Ligula nodosa*	Dujardin	1845 : 629.
1850	*Ligula monogramma*	Diesing	1850 : 579.
1850	*Ligula digramma*	Diesing	1850 : 580.
1853	*Ligula interrupta*	Baird	1853 : 96.
1853	*Ligula sparsa*	Baird	1853 : 96.
1854	*Ligula monogramma*	Diesing	1854 : 19.
1854	*Ligula digramma*	Diesing	1854 : 18.
? 1856	*Ligula reptans*	Leidy	1856 : 46.
1863	*Ligula monogramma*	Diesing	1863 : 230.
1863	*Ligula digramma*	Diesing	1863 : 231.
1870	*Ligula monogramma*	Willemoes-Suhm	1870: 94.
1877	*Dibothrium ligula*	Donnadieu	1877 : 495.
1881	*Ligula simplicissima*	Moniez	1881 : 37,81.

1882	<u>Ligula simplicissima</u>	Kiessling	1882.
1884	<u>Dibothrium ligula</u>	Zschokke	1884 : 26.
1885	<u>Ligula simplicissima</u>	Schauinsland	1885 : 550.
1888	<u>Ligula simplicissima</u>	Niemiec	1888 : 2.
1893	<u>Ligula monogramma</u>	Olsson :	1893 : 15.
1894	<u>Ligula simplicissima</u>	Stiles &Hassall	1894:331.
1895	<u>Ligula monogramma</u>	Zernecke	1895 : 93.
1895	<u>Ligula digramma</u>	Zernecke	1895 : 93.
1896	<u>Ligula simplicissima</u>	Zschokke	1896 : 773,774,775.
1898	<u>Ligula digramma</u>	Cohn	1898 : 134.
1898	<u>Ligula uniserialis</u>	Luehe	1898 : 286.
1898	<u>Ligula uniserialis</u>	Muehling	1898 : 32.
1898	<u>Ligula monogramma</u>	Stossich	1898 : 118.
1899	<u>Ligula intestinalis</u>	Luehe	1899 : 52.
1900	<u>Ligula avium</u>	Braun	1900 : 1687.
1900	<u>Ligula uniserialis</u>	Wolffhuegel	1900 : 63.
1901	<u>Ligula intestinalis</u>	Linstow	1901.
1902	<u>Ligula monogramma</u>	Parona	1902 : 7.
1902	<u>Ligula intestinalis</u>	Schneider	1902a: 13.
1903	<u>Ligula intestinalis</u>	Linstow	1903 : 20.
1910	<u>Ligula intestinalis</u>	Luehe	1910 : 18.

Specific diagnosis: With the characters of the genus. Large worms from 100 to 1000mm.in length by 5 to 15 in breadth. Anterior end rounded,protruding,bothria faint. Strobila greatly elongate,depressed,maximum breadth anterior to the middle,gradually tapering to the posterior end. Body crossed by irregular ridges and furrows,and wavy at the margins in the adult with 35 to 40 external segments anteriorly. Deep median groove on each surface

in the larva, two very shallow parallel grooves near the median line on the dorsal surface in the adult.

Cuticula 5 - 20μ in thickness, sub cuticula 70 -100. Nerve strands 50μ in diameter. Excretory vessels numerous in two layers, one close beneath the vitelline glands(cortical) another among the main body muscles.

Genitalia from 0.10 to 0.20mm. apart. Genital cloaca a narrow transverse slit, 0.18-0.20 x 0.02 - 0.03mm. into which open separately the cirrus, uterus and vagina, the latter constantly between the other two which alternate irregularly from side to, side.

Testes in single dorsal layer in the medulla, interrupted only medially, 35 tp 40 in transection, 115 x 85 x 45μ in dimensions. Vas deferens up to 30μ in diameter, loosely coiled above the cirrus sac. Seminal vesicle small, close above the latter, 65 - 80 x 40 - 65μ. Cirrus-sac somewhat lateral, ovoid, with thin walls, 185-200 x 130-145 x 130-135μ. Cirrus proper within cirrus-sac, long and coiled, 25μ in diameter.

Vagina 15 to 30μ in diameter, receptaculum seminis 75μ. Spermiduct short, 25 x 12μ. Ovary 1.5mm. in diameter; wing greatly depressed, isthmus prominent and not in the median line but alternating irregularly from side to side opposite the cirrus-sac; ova in same 15 x 13μ. Oocapt 18-20μ in diameter, oviduct 15-20μ. Vitelline reservoir ellipsoidal in shape, 50-60 x 30μ, in a layer close beneath the subcuticula and broken only ventrally. Shell-gland composed of much elongated cells with enlarged bodies and narrow necks connecting with the oviduct for 30μ of its length. Uterus a mass of coils in the median line, 0.5-0.6mm. im diameter, that of the tube being 60μ.

Eggs, 49-65 x 31-42μ.

Habitat : As larvae in the body-cavities of teleosts; adults in the intestines of wading and diving birds.

Host	Locality	Collector	Authority	
Leuciscus vulgaris		Pallas	Diesing	1850:581.
" rutilis		Hubner	"	" ".
" "		Zschokke	Zschokke	1884:26.
" "	Rossitten	Muehling	Muehling	1898:33.
" "	Orlja-See, Petrograd.	Birulja	Linstow	1903:285.
" "	Gez-bartlank, Astrabad Bay, Caspian Sea.	Maximovic	"	" "
" leuciscus	------------	---------	Luehe	1910:19.
" erythro-ophthalmus	-----------	Bremser	Diesing	1850:581.
" pulchellus	-----------	Baird	Leidy	1855:444.
" phoxinus	L. Storsjön, Jemtland, and Bönan, Sweden.	Olsson	Olsson	1893:15.
Abramis blicca	-----------	Goeze	Diesing	1850:581.
" brama	-----------	Rudolphi	"	" ".
" "	-----------	Bremser	"	" ".
" "	-----------	M. Siebold, Coll. Brit. Museum.	Baird	1853:95.
" "	L. Finjasjön, Scania, Sweden.	Olsson	Olsson	1893:15.
" "	-----------	Zschokke	Zschokke	1896:775.
" "	East Prussia	Schauinsland	Muehling	1898:33.
" "	Ladoga-See	Firlei	Linstow	1903:285.
" "	Astrachan	Baer	"	" ".

Abramis vimba	Petrograd	Prichodko	Linstow	1903:285.
" bjorkna	---------	----------	Luehe	1910:19.
Cyprinus brama	---------	Bloch	Bloch	1782:2.
" "	---------	Borke	Goeze	1783:187.
Cyprinus gobio	---------	Bloch	Bloch	1782:2.
Cyprinus alburnus	---------	"	"	" ".
" "	Berlin	Goeze	Goeze	1782:187.
Cyprinus tinca	---------	Bonnet	Bloch	1782:2.
" blicca	---------	----------	Rudolphi	1810:19.
" carassius	---------	Pallas	"	" 22.
" "	---------	Creplin	Creplin	1839:296.
" lacustris	Italy	Briganti	Donnadieu	1877:339.
" leuciscus	La Reole & Neuffons	Queyron	Queyron	1905:CVI.
Aspius alburnus	----------	Bremser	Diesing	1850:581/
" rapax	Iljmen-See, Novogorod	Varpachov-skij	Linstow	1903:285.
Gobio vulgaris	----------	Rudolphi	Diesing	1850:581,
" fluviatilis	Basel	Zschokke	Zschokke	1896:774.
" "	Rossitten	Muehling	Muehling	1898:33.
" "	Angara-Fluss, Siberia	Cekanovskij	Linstow	1903:285.
Carassius gibelio	----------	Rudolphi	Diesing	1850:581.
" vulgaris	----------	Diesing	"	" :579.
" "	Saratov	---------	Linstow	1903:285.
" carassius	---------	----------	Luehe	1910:19.
Ammocoetes branchialis	---------	Schrank	Diesing	1850:581.
Petromyzon branchialis	--------	Schrank	Rudolphi	1810:24.
Cobitis taenia	----------	Frisch	"	1819:134.
" "	----------	Bloch	"	" ".

Cobitis aculeata	----------	Bloch	Bloch	1782:2.
Salmo salvelinus	----------	Schrank	Diesing	1850:581.
Coregonus wartmanni	----------	" .	"	" ".
Siluris glanis	----------	Mus.Vienna	"	" ".
Esox lucius	----------	" "	"	" ".
" "	Sweden	Olsson	Olsson	1893:15.
Perca fluviatilis	----------	Mus.Vienna	Diesing	1850:581.
" "	L.Storsjön, Jemtland,and Bönan,Sweden	Olsson	Olsson	1893:15.
Lucioperca sandra	----------	Mus.Vienna	Diesing	1850:581.
" lucioperca	----------	----------	Luehe	1910:19.
? Phoca vitulina	Berlin	Rudolphi	Rudolphi	1819:135.
Morrhua americana	----------	Schafirt	Leidy	1855:444.
Squalius cephalus	----------	Zschokke	Zschokke	1884:26.
" turcicus	Tschaldyr-göl See,Armenia	Brandt	Linstow	1903:285.
Alburnus lucidus	----------	Zschokke	Zschokke	1884:26.
" "	Jedwabno	Braun	Muehling	1898:33.
" "	Langviken Bay, Finland.	Levander	Schneider	1902a:13.
" alburnus	----------	----------	Luehe	1910:19.
Atherina mocho	Cagliari	Parona and Mazza	Par.&Mazz.	1900:233.
Blicca bjorkna	----------	Linstow	Linstow	1901:629.
Catostomus ardens	Yell.Nat.Park	D.S.Jordan	Linton	1891:65.
Chondrostoma nasus	Basel	Zschokke	Zschokke	1896:775.
Catostomus latipinnis	Gila R. and Salt R.,Arizona	E.Palmer	Linton	1897:438.
Osmerus mordax	Potomac R., Hagerstown,Md.	C.L.Ridenour	"	" "

Hybognathus nuchalis	----------	----------	Linton	1897:438.
Notropis cornutus	Fourth L., Adirondacks, New York	F.Mather	"	" "
Schizopygopsis kozlovi	Tan-la-Gebirge, Tibet	Prževalskij	Linstow	1903:285
Nemachilus strauchi	Issyk-kul-See, Bai Karasu	P.Schmidt	"	" "
" "	Prževalskij-Bai, Aral Sea	"	"	" "
Tinca vulgaris	-----------	-----------	Neveu-Lemaire	1902 :88.
Gobio gobio	-----------	-----------	Luehe	1910 :19.
Scardinius erythrophthalmus	-----------	-----------	"	" "
Ameiurus sp.	Charlevoix, Michigan	H.B.Ward	Cooper (the present paper)	
Alosa ohiensis	Keokuk, Iowa	"	"	
Perca fluviatilis	Walnut L., Mich.	"	"	
" flavescens	Go-Home Bay, Muskoka District, Ontario.	Cooper	"	
Catostomus commersonii	Walnut L., Mich.	H.B.Ward	"	
" "	Turtle L., Mich.	H.R.Hill	"	
Notropis cornutus	Go-Home Bay	Cooper	"	
" cayuga	Turtle Lake,	H.R.Hill	"	
Micropterus dolomieu	Go-Home Bay	Cooper	"	
Ambloplites rupestris	" "	"	"	
Gasterosteus bispinosus atkinsii	Chamcook L, New Brunswick	"	"	
Free on Shore	Turtle L., Mich.	H.R.Hill	"	

Adult stage:

Falco chrysaetos	----------	Braun	Diesing	1850:580.
" albicilla	----------	Bremser	"	" "
" "	----------	Mus.Vienna	Rudolphi	1819:133.
" "	Greiphswald	Creplin	Creplin	1839:296.
" fulvus	----------	Braun	Rudolphi	1810:12.
Ciconia alba	----------	Hildebrandt	Diesing	1850:580.
" ciconia	----------	---------	Luehe	1910:18.
" nigra	----------	---------	"	" " .
Ardea ciconia	----------	Hildebrandt	Rudolphi	1810:16.
" egretta	----------	Mus.Vienna	"	1819:133.
" alba	----------	M.C.V.	Diesing	1850:580.
" nycticorax	----------	"	"	" " .
" sp.	Desertus Kirgisorum	Slovcov	Linstow	1903:284.
Totanus glottus	----------	M.C.V.	Diesing	1850:580.
" chloropus	----------	Mus.Vienna	Rudolphi	1819 :133.
Colymbus arcticus	----------	" "	"	" :134.
" "	----------	Mehlis	Diesing	1850 :581.
" auritus	----------	Hubner	Rudolphi	1810:15.
" "	----------	Bloch	Bloch	1782:4.
" cristatus	----------	Rudolphi	Stiles & Hassall	1912:266.
" "	----------	Mus.Vienna	Rudolphi	1819;134.
" griseigena	----------	----------	Luehe	1910:18.
" rubricollis	----------	~~Nitzsch~~---	Nitzsch	1824:98.
" septentrionalis	-------	Mus.Vienna	Rudolphi	1819 :134.
" "	----------	Mehlis	Diesing	1850:581.
" "	----------	----------	Luehe	1898:286

Colymbus subcristatus	--------	Mus.Vienna	Rudolphi	1819:134.
Podiceps auritus	-----------	Bloch	Diesing	1850:581.
" "	-----------	Hübner	"	" " .
" "	Rennes,France	Dujardin	Dujardin	1845:629.
" "	-----------	M.C.V.	Diesing	1850:580.
" "	-----------	M.Siebold, Coll.Br.Mus.	Baird	1853:96.
" "	Ireland	Bellingham	Belling-ham	1844:165.
" "	Koenigsberg	Braun	Muehling	1898:32.
" "	Pillau	Muehling	"	" " .
" "	Trieste	Stossich	Stossich	1898:118.
" "	-----------	Wolffhügel	Wolffhügel	1900:62.
" "	-----------	Linstow	Linstow	1901:629.
" "	Venice	Stossich	Parona	1902:7.
" "	Varese	Parona	"	" " .
" minor	Monfalcone	Stossich	Stossich	1898:118.
" nigricollis	Trieste	"	"	" " .
" rubricollis	----------	M.C.V.	Diesing	1850:580.
" "	Trieste	Stossich	Stossich	1898:118.
Anas boschas fera	-----------	Mus.Vienna	Rudolphi	1819:134.
" boschas	-----------	----------	Luehe	1910:18.
Larus argentatus	Gryphswald	Schilling	Diesing	1854:19.
" "	Kainsk,Enissej	Middendorff	Linstow	1903:20.
" canus	-----------	Bremser	Rudolphi	1810:13.
" melanocephalus	Varese	Parona	Parona	1902:7.
" parasiticus	-----------	Bremser	Rudolphi	1810:13.
" "	-----------	Mus.Vienna	"	1819:135.

Larus pelecanus carbonis	-----------	Mus.Vienna	Rudolphi	1819:133.
Larus pygmaei	------------	" "	"	" ".
" ridibundus	-----------	Bremser	"	1810:13.
" "	Rossitten	Muehling	Muehling	1898:33.
" tridactylus	-----------	Hübner	Rudolphi	1810:13.
Sterna hirundo	-----------	Mus.Vienna	"	1819:133.
" nigra	-----------	" "	"	" "..
Mergus albellus	-----------	Bloch	Bloch	1782:4.
" "	-----------	M.C.V.	Diesing	1850:581.
" merganser	-----------	Nitzsch	Rudolphi	1819:133.
" "	-----------	Bloch	Bloch	1782:4.
" "	Belgium	Beneden	Diesing	1863:231.
" "	-----------	Linstow	Linstow	1901:629.
" minutus	-----------	----------	Gmelin	1790:3042.
" serrator	------------	M.C.V.	Diesing	1850:581.
" "	-----------	Muehling	Muehling	1898:33;
" "	Gulf of Finland	Schneider	Schneider	1902a:13.
Nycticorax sp.	-----------	Mus.Vienna	Rudolphi	1819:133.
" nycticorax	-----------	----------	Luehe	1910:18.
Graculus carbo	-----------	M.Siebold, Coll.Br.Mus.	Baird	1853:96
Fuligula clangula	Jemtland	Olsson	Olsson	1893:15.
Xema minutum	Trieste	Stossich	Stossich	1898:118.
" ridibundum	-----------	Wolffhügel	Wolffhügel	1900:63.
Urinator arcticus	-----------	----------	Luehe	1900:18.
" stellatus	-----------	----------	"	" "
Rissa tridactyla	-----------	----------	"	" "
Stercorarius parasitica	-----------	----------	"	" "

Hydrochelidon nigra	------------	----------	Luehe	1910: 18.
Herodias alba	------------	----------	"	" " .
Haliaetus albicilla	----------	----------	"	" " .
Aquila chrysaetus	-----------	----------	"	" " .
Corvus cornix	-------------	-----------	"	" " .
Podilymbus podiceps	------------	H.B.Ward	Cooper (the present paper)	
Merganser species	Urbana,Illinois	"	"	
Colymbus hoelboelli	-----------	"	"	

As indicated in the above synonymy, the greatest confusion existed in connection with this species even from the time of Linnaeus, all of the older writers recognizing at least two species, the larval and the adult, and many, several species under each of these. Rudolphi (1810), for instance, accepted four species of the former, "ovariis occultatis", and the same number of the latter, parasitic in the intestines of birds, "ovariis distinctis". In his Entozoorum Synopsis (1819) he reduced the number of larval species to two, but retained the same four adult forms as before. The next important move in a systematic direction was by Creplin (1839) who divided Rudolphi's L. simplicissima into two larval species, viz., L. monogramma and L. digramma, corresponding respectively to the previously known L. uniserialis and L. interrupta (or alternans), which plan was followed by Diesing (1850, 1854, and 1863) while Dujardin (1845) and Baird (1853) followed Rudolphi. Diesing (1850 : 581) erected a third species, L. reptans, to accommodate numerous forms found encysted in the muscles and connective tissues of amphibians, reptiles, birds and mammals; but, as pointed out by Janicki (1906 : 519-520) several larval species were probably included under this heading. Those from avian hosts (l.c.: 582) are not given above since they were found only among the muscles and under the skin, where L. intestinalis has never been found in birds, so far as the available records indicate. Luehe (1910 : 18) did not include them in his list of hosts for the adult stage of the species.

Next in order of importance came Donnadieu's (1877) classical experiments in which, after completely reviewing the

literature up to date, he conclusively proved that the form found in the body cavities of various bony fishes is the larval stage of that present in the intestines of birds. As a result of his work he combined the two forms under a new name, *Dibothrium ligula*, confusing at the same time *Schistocephalus solidus* with *Ligula intestinalis*. The life-history of the species was later studied by Riehm (1882) by feeding methods. Moniez (1881: 37, 81) was the first writer to study the histology of the species, while Kiessling (1882) gave us the first description of its general anatomy. As emphasized, however, by Linstow (1901), Kiessling's work is not very specific, since he almost constantly disposed of *L. intestinalis* by saying that in it conditions were the same as in *Sch. solidus*. While, apart from Donnadieu and the earlier writers, Willemoes-Suhm (1870 : 94) was the first to study the development of the embryo with attention to detail. Schauinsland (1885 : 550) enlarged upon his observations and gave a more or less complete description of the process up to the time of the escape of the ciliated larva. Niemiec (1888 : 2) described the nervous system, and Cohn (1898 : 134) pointed out its resemblances to *Sch. solidus* in this regard. Zernecke (1895) in the meantime dealt in his well known work on the finer structure of cestodes with the parenchyma and the nervous and muscular systems in particular, since when little has been done in that connection. The question of segmentation was studied by Luehe (1898); and later the same writer (1899: 53) placed the species in his first classification, stating his belief that there is only one species of *Ligula*, viz., *L. intestinalis* (L.). The latter conclusion was also arrived at by

Linstow (1901 : 628), altho he attributed the specific name to Goeze; while in his latest classification Luehe (1910) maintained the same view.

Consequently, taking for granted in the absence of European material for comparison, that the latter has been established as a fact for the European forms, it is for the present writer to determine whether we have here in America the same species. And so far as the majority of specific characters are concerned, we have to rely on the descriptions of Kiessling and Linstow (1901) who seem to have been the only writers to attend to the details of the reproductive system, and, as mentioned above, Kiessling's is quite inadequate in this connection. The only American reports of the species are of larval forms : L. monogramma by Leidy (1855 : 444) and Dibothrium ligula by Linton (1897 : 438), the former having also listed (1856 : 46) the doubtful L. reptans.

Luehe (1910 : 18) gave the dimensions of the species as 100-400mm. (occasionally 1 metre) in length by from 5 to 15mm. in breadth, not distinguishing, however, between the larva and the adult in this regard. Linstow (1901 : 629) reported a larva from Blisca bjorkna 200mm. long, 9 broad and 3.5 thick, adults from Podiceps cristatus and Mergasser merganser being 160mm. long, 4 broad and 1.5 thick; and concerning these differences said that: "Wenn man die Geschlechtsform aus Vögeln oft kleiner findet als die Larve aus Fischen, so mag das seinen Grund darin haben, dass die letztere sich in der Grösse ihren Wirth anpasst; die grossen Larven in grossen Fischen können aber nicht von kleineren Vögeln verschlungen werden." The largest larval specimen at hand was one

from <u>Catostomus</u> <u>commersonii</u> which measured 425mm. in length by 15 in maximum breadth, but the largest adult from <u>Merganser</u> sp. was only 142mm. by 7.5. In the larva the anterior end is somewhat bluntly rounded (Fig. 1) the bothria being visible as very short grooves passing over the tip, while in the adult they are more elongated and distinct, the end of the strobila being somewhat protruded, as shown in Fig. 2. On each surface of the larva there is a deep, median, longitudinal furrow, which, however, becomes obliterated in the adult, excepting anteriorly,by the growth of the reproductive organs, the ducts of which ar con- fined to the median line of the strobila. When these are developed the strobila is characterized dorsally by a low median ridge bounded on each side by a quite shallow groove, and ventrally by a greater thickening of the median line, not separated, however, by any grooves from the lateral regions. The whole strobila gradually tapers from a short distance behind the anterior end, where the maximum breadth is located, to the posterior end. Whereas in the larva it is quite thick, in the adult it is thin and leaf-like, the margins usually appearing, especially posteriorly, wavy in alcoholic specimens. A pseudosegmentation is present in the anterior end of the strobila, but as has been known, especially since Luehe (1898) emphasized the fact, this division of the strobila into segments does not correspond with the internal division into true proglottides. Gemmill (1909 : 11) counted about 50 of them in the anterior third of the worm, the writer 38 or 39 for a distance of 13mm. from the tip of one adult specimen (Fig. 2) and 36 for 10mm. in another. They vary considerably

in length and are often incomplete medially. From the anterior region showing external segmentation to the posterior end both larvae and adults, but particularly the latter, are crossed by very numerous irregular grooves which give the worm its characteristic appearance, apart from the general shape, as contracted, for instance, with the closely related Schistocephalus solidus (vide infra). The smallest larva met with was one from a small specimen of Micropterus dolomieu, 47mm. in length. It gave the following measurements: length, 4.9mm.; maximum width, 0.54; width one third the length from the anterior end, 0.54, two-thirds, 0.37; length of bothrial groove, ? 0.07mm. All sizes from this to the largest mentioned above were at hand.

The enticula was found to have a thickness of from 5 to 10μ, compared with 16-18 μ by Kiessling and 2.1 μ (!) by Linstow. It was seen to be homogeneous in the sections made rather than divisible into the three layers described by the former, with some tendency, however, for the outer one-quarter to one-sixth to take the stain much less than the remainder of the tissue, which outer clearer area is often bounded by a very delicate pseudo-ciliated layer. There was found to be as much variation not only in the thickness of the enticula but also in its structure, that nothing more will be said excepting that these remarks apply to the larva as well as to the adult. The subcuticula varies from 70 to 90μ, — 33-49 μ according to Kiessling and 114 μ to Linstow. Calcareous bodies in the characteristically fine parenchyma, described by Moniez and Zernecke, and given dimensions of 13 x 7.8 μ by Linstow, were not observed to the writer's satisfaction.

The musculature has been well described histologically by Zernecke (1895); while Kiessling spoke rather briefly of its arrangement in the late larva. Later Luehe dealt with the system in general (1897a and 1898) and its relation to the nervous system (1896), and Linstow (1901), gave a concise account of its arrangement. The writer has nothing of importance to add to the contributions of these authors.

The chief nerve strands were found in transections between the lateral and median quarters of the transverse diameter of the strobila, in the median frontal plane that is below the neighboring testes, and with a diameter of 50 μ. The details of the system have been studied by Moniez (1881), Niemiec (1888), Zernecke (1895) and Cohn (1898), the latter of whom found conditions pretty much as in Schistocephalus, namely, that each chief strand has associated with it six collateral strands, arranged in three groups oftwo each.

The excretory system was studied by Moniez and Zernecke in considerable detail. As pointed out by Linstow two regions accommodating numerous longitudinal vessels are present: (1) an outer, close beneath the vitelline glands, and (2) an inner, between the inner longitudinal and transverse muscles, or as Linstow figured, between the former themselves. In the material studied the outer-plexus showed very plainly, but the inner vessels were found among both sets of muscles and not nearly as distinct as the outer ones.

The sets of genitalia, beginning about 10mm. from the anterior end and very closely crowded together in the longitudinal

direction, were found to lie from 0.14 to 0.18mm. apart, 0.13-0.15mm. being the data given by Linstow. The openings are usually almost exactly in a transverse line, but the cirrus and uterus openings alternate irregularly from side to side, that of the vagina being constantly in the middle. This alternation of the openings is due to the similar alternation of the internal organs and evidently was the basis upon which the earlier species L. digramma and alternans were established. The genital cloaca is a quite irregular transverse depression, 0.18-0.30mm. in width and 0.03-0.03mm. in length, the respective measurements by Linstow being 0.106 and 0.026mm.

"The testes lie in a single row, which is only interrupted by the uterus, on the dorsal side of the medulla ... ". They are from 35 to 40 in number in transections, ellipsoidal in shape, their greatest diameters being transverse, as indicated by the maximum width, length, and depth being, respectively, 115, 45, and 85 μ . Linstow gave them as 150 to 180 μ long by 88 to 156 μ wide. The loosely coiled vas deferens is situated above the cirrus-sac (Fig. 3) and is roughly divided into two parts by the laterial coils of the uterus, one part being immediately above the cirrus-sac and the other close to the dorsal body-wall. The duct attains a diameter of 30 μ when filled with spermatozoa. Distally it expands into the very small (as compared to that of Sch. solidus) seminal vesicle, situated close to the dorsal wall of the cirrus-sac. The vesicle was found to be from 65 to 80 μ in length by 40-65 in diameter (156 x 86 μ , Linstow), oval in shape, the narrower end towards the cirrus pouch, and provided with only a

comparatively feeble musculature. The wall of the structure is richly supplied both internally and externally with nuclei which are respectively those of the lining epithelium and the myoblasts, as in Schistocephalus (vide infra). The epithelium is strongly ciliated. The cirrus-sac (Fig. 3) is an ovoid body, somewhat flattened dorso-ventrally and obliquely by the uterus and alternating irregularly from right to left, always occupying the opposite side of the median line from the ovarian isthmus and the neighboring female ducts. Its wall is quite thin, while apart from the cirrus proper which occupies the distal two-thirds, the contents consist of loose parenchyma and few retractor muscles. The measurements of the organ in sections are: dorsoventral diameter, 185-200 μ; width 130-145; and length, 130-135; which are quite at variance with Linstow's diameter of 53 μ of what he described as a spherical organ. Within the cirrus-sac the vas deferens is not sharply separated into ejaculatory duct and cirrus proper, altho the latter is quite distinct, closely coiled and as much as 25 μ in diameter.

The vagina opens into the common genital cloaca, if one may use that name for the depression mentioned above, in the median line and usually equidistant from the openings of the cirrus and uterus. It passes dorsally thru the cortex and the musculature with almost a straight course and then within the medulla turns sharply posterolaterally, in which portion of its course it has a diameter of from 15 to 30 μ (5 μ, Linstow). Its thin lining of cuticula, directly continuous with that of the genital depression, gradually passes into a nucleated epithelium, in which no distinct cell boundaries were made out, just within the cortex. Dorsal to

the ovarian isthmus it enlarges into an elongated receptaculum seminis which was found to have a maximum diameter of 75 μ. Linstow described a spindle-shaped serminal receptacle, 13 μ in diameter, and an oocapt as follows: "dorsal von der Vereinigungsstelle der beiden Keimstocksflügel liegt der ovale, 0.028mm. lange und 0.066mm. breite Schluckapparat"; each of which, however, in comparison with that described here by the writer and for <u>Sch. solidus</u> below, seems to be confused with the other. At least the oocapt of none of the bothriocephalids studied was found relatively so large as indicated by Linstow in his measurements and in his figure, nor was the receptaculum as spindle-shaped as shown in the latter. In this connection Kiessling described a swelling of the vagina, 46 μ in diameter, which contained spermatozoa. The spermiduct is so short and of such a small calibre that it is quite difficult to locate it in sections. It unites with the oviduct a short distance from the oocapt (Fig. 4) much as in <u>Sch. solidus</u>, after pursuing a horizontal course. It is about 25 μ in length and 12 μ in diameter. The ovary is asymmetrical, as stated by Kiessling but denied by Linstow, since it consists of a much depressed lateral wing, situated close to the ventral musculature (Fig. 3) and a more median enlarged portion which functions as the isthmus in that the oviduct arises from it. This isthmus-like region is not in the median line but about 0.25 mm. from it, the whole organ alternating irregularly from right to left, constantly opposing the cirrus-sac on the other side. It varies from 0.55 to 0.64mm. in width and has a length laterally of 0.12mm. Its unusual situation is evidently due to the closely crowded condition

of the reproductive organs and the pressure exerted by the large uterus in the median line. Whereas the wing has a maximum dorso-ventral diameter of about 60 μ , the isthmus is about 35 μ in depth and roughly ellipsoidal in shape, protruding in sections from the dorsal region of the junction of the wing (Fig. 3). Ova from the isthmus were found to be oval in shape and 15 x 13 μ in size (13-16 μ, Linstow). The oocapt is directed horizontally away from the side of the isthmus and from the median line. Its diameter is 18-20 μ, with which compare the dimensions of 88 x 88 μ given by Linstow (vide supra). The oviduct has a diameter of from 15 to 20 μ . Taking a general dorsal course after being joined by the spermiduct, it soon receives the common vitelline duct (Fig. 4) which has only a limited enlargement from a previous diameter of 10-20 μ to 30 μ to form the vitelline reservoir which is located close to the oviduct with a length of 40 μ . The vitelline follicles are situated in a layer close beneath the subcuticula and are continuous, excepting in the median ventral line. The individual follicles, very irregular in shape, are 50-60 μ in depth and 30 μ in width, Linstow's measurements being 65 x 47 μ and Kiessling's 6 μ in the larva. Concerning the shell-gland Linstow said: "Die Schalendruse ist ein 0.088-0.105mm. grosses Organ, das dorsal von der Mitte des einen Keimstockflügels an der Entsprechenden Aussenwand der Uterus liegt; die Zellen, deren kleiner Kern sich intensiv färbt, sind 0.0039mm. gross." In the sections made by the writer it was found to be a quite irregular structure, composed of greatly elongated club-shaped cells with necks of different lengths which unite with the oviduct in a region only

about 30 in length and situated just beyond the point of reception of the common vitelline duct (Fig. 4). These cells are so loosely arranged and their proximal attenuated portions of such a filiform nature that they are very easily overlooked, especially since they are scattered thruout the whole of the dorsoventral diameter of the medulla of the region and are interwoven among the oviduct, the receptaculum, the vitelline duct and the beginning of the uterus. They form by no means such a compact organ as Linstow's description and figure would indicate. The distal ends of the cells are about 15 x 10 μ in size, while their nuclei are about 4 μ in diameter. Kiessling described the shell gland as similar to that of Sch. solidus and as follows: "Die Schalendrüse besteht aus Drüsenzellen, welche an feinen Stielchen befindliche Bläschen an der Oberfläche einer Halbkugel angeordnet sind and ihre Stielchen als Radien nach dem Mittelpunkte der Kugel senden"; and his figures of such a compact region are likewise quite different from conditions described here. The uterus forms a mass of coils, 0.5-0.6mm. in diameter in the median line, from which a straight portion passes ventrally thru the musculature and cortex to the opening which is about 20 μ in diameter (35 , Linstow). The diameter of the duct is 60 μ in the median frontal plane but only half that amount as it passes thru the longitudinal muscles. The measurements of the eggs are according to Kiessling and Linstow, respectively, 49 x 34 μ and 65 x 42 μ : they were found by the writer to be 52-54 x 31-33 μ in sections.

Our knowledge of the life-history of the species is confined chiefly to the works of Duchamp (1876), Donnadieu (1877)

and Riehm (1882) who firmly established the well known fact that the larva present in the abdominal cavities of various species of teleosts develops rapidly in the intestines of fish-eating birds. The production of eggs begins after about 36 hours, while the adults live for from three to four days only in the definitive hosts. But apart from these and other closely related details which were brought out by Donnadieu by means of well conducted and controlled experiments, nothing is known, so far as the writer is aware, of the development of the oncosphere in the intermediate host up to the time when they become distinguishable as small larvae. The measurements of the smallest larva found by the writer have been given above; Figs. 5 and 6 are of two slightly larger specimens, the latter being 6.1mm. in length by 1.34mm. maximum breadth.

Altho the above description shows many discrepancies between the species as here dealt with and the European form, the writer does not feel justified in separating the two specifically, especially in the absence of European material for comparison. The thickness of the cuticula, and subcuticula, the dimensions of the testes, seminal vesicle and cirrus-sac and the diameter of the vagina show the greatest differences, apart from the probable confusion by Linstow of the oocapt and receptaculum seminis, while the measurements of the eggs as here given are somewhat intermediate between those by Kiessling and Linstow. But the fact that the data given by the latter are apparently the only adequate ones for the adult and that there are not a few discrepancies between Kiessling's and Linstow's accounts restrains the writer from

looking upon this, the American form, as new. In dealing with this question of identity we must also remember that not only does the species vary so much that, as pointed out above, a great deal of confusion exists in the earlier literature but that the number of host species of the larva as well as of the adult is very large as compared to other species of bothriocephalids, hence introducing greater factors for variation; and above all that the geographical distribution of the wading and diving birds harboring the mature worms is such that here in America we have amny of the same species as well as the same genera that occur in Europe. As the above record of hosts indicates, the species certainly ranges widely over Europe and Northern Asia, so that it would be quite surprising if it did not occur here in North America, with the probable region of transition in Iceland and Greenland on the east and Northeastern Siberia and Yukon on the west. However, apart from Leidy's and Linton's records it has apparently not been reported up to the present.

The material studied by the writer consisted of the following lot of larvae: Nos. 4706 and 4708 of the Collection of the United States National Museum; Ch 18a, 16.411, 16.413, 16.414, 16.419, 17.31 and 17.32 of the Collection of the University of Illinois, under the care of Professor H. B. Ward; Nos. II, III, IV, and V from the Collection of Mr. H. R. Hill made at Turtle Lake, Michigan; and Nos. 47, 54, 150, 158, 159, 160, 189, and 190 of the writer's collectinn; and the adults contained in Nos. La-156, 17.184, and 17.185, C. U. Ill. respectively from the intestines of Merganser sp., Podilymbus podiceps and Colymbus holboellii.

Genus 2. Schistocephalus Creplin, 1829.

Taenia (part.)	Auctorum.
Hirudo (part.)	Linnaeus, 1745.
Fasciola (part.)	Linnaeus, 1767.
Rhytis (part.)	Zeder, 1800.
Halysis (part.)	Zeder, 1800.
Bothriocephalus (part.)	Rudolphi, 1808.
Schistocephalus (part.)	Creplin, 1829.

Generic diagnosis: Bothria and external segmentation already developed in the larva. The tip of the scolex retractile. Segmentation complete and corresponding to the internal structure of the animal. Longitudinal and transverse muscles arranged in several alternating layers (three transverse layers enclosing two longitudinal layers).

Type (and only) species: Sch. solidus (O.F. Mueller).

Schistocephalus solidus (O.F. Mueller, 1776).

(Figs. 7 - 9.)

Larval stage:

1734	Taenia	Frisch	1734 : 395.
1745	Hirudo depressa alba	Linnaeus	1745 : 250.
1758	Fasciola hepatica	Linnaeus	1758 :648
1761	Taenia lata	Pallas	1761 : 410.
1767	Fasciola hepatica	Linnaeus	1767 : 1077.
1776	Taenia solida	Mueller	1776 : 219.
1780	Taenia gasterostei	Mueller	1780 : 22.
1780	Taenia gasterostei	Fabricius	1780 : 320.
1781	Taenia acutissima	Pallas	1781 : 76,78.

1786	Taenia gasterostei	Batsch	1786 : 224.
1788	Taenia solida	Schrank	1788 : 49.
1790	Taenia solida	Gmelin	1790 : 3079.
1790	Taenia gasterostei	Abildgaard	1790 : 49-58.
1800	Rhytis solida	Zeder	1800 : 297.
1810	Bothriocephalus solidus	Rudolphi	1810 : 57.
1819	Bothriocephalus solidus	Rudolphi	1819 : 139,477.
1819	Bothriocephalus solidus	Bauckart	1819 : 46.
1824	Bothriocephalus solidus	Nitzsch	1824 : 97.
1829	Bothriocephalus solidus	Baer	1829 : 388.
? 1863	Schistocephalus ~~rhynch-~~ ichthydid	Diesing	1863 : 233.
1896	Sch. dimorphus	Zschokke	1896 : 773.
1896	Schistorhynchus dimor-phus	Zschokke	1896 : 776.
1897	Schistocephalus dimor-phus	Linton	1897 : 427.
1898	Schistoc. solidus	Cohn	1898 : 126.
1898	Schistoc. solidus	Muehling	1898 : 33.
1899	Schistoc. solidus	Luehe	1899 : 52.
1909	Schistoc. solidus	Scott	1909 : 80.

Adult stage:

1782	Taenia lanceolata nodosa	Bloch	1782 : 10.
1786	Taenia lanceolata var.	Batsch	1786 : 167.
1788	Taenia nodularis	Schrank	1788 : 39.
1790	Taenia lanceolata nodosa	Gmelin	1790 : 3075.
1790	Taenia gasterostei	Abildgaard	1790 : 49-58.
1793	Taenia lanceolata nodosa	Rudolphi	1793 : 41.
1800	Halysis alnceolato-nodosa	Zeder	1800 : 340.

1810	Bothriocephalus nodosus	Rudolphi	1810 : 54.
1819	Bothriocephalus nodosus	Rudolphi	1819 : 140.
1819	Bothriocephalus nodosus	Leuckart	1819 : 58.
1824	Bothriocephalus nodosus	Nitzsch	1824 : 97.
1829	Schistocephalus dimorphus	Creplin	1829 : 95.
1839	Schistoc. dimorphus	Creplin	1839 : 290.
1845	Schistoc. dimorphus	Dujardin	1845 : 622.
1850	Schistoc. dimorphus	Diesing	1850 : 584.
1853	Schistoc. dimorphus	Baird	1853 : 92.
1854	Schistoc. dimorphus	Diesing	1854 : 19.
1858	Schistoc. solidus	R.Leuckart	1858 : 129.
1859	Schistoc. solidus	Steenstrup	1859 : 475.
1863	Schistoc. dimorphus	Diesing	1863 : 232.
1869	Schistoc. dimorphus	Willemoes-Suhm	1869 : 469.
1877	Dibothrium ligula	Donnadieu	1877:: 495.
1881	Schistoc. dimorphus	Monniez	1881 : 175.
1882	Schistoc. dimorphus	Kiessling	1882
1889	Schistoc. solidus	Loennberg	1889 : 40.
1890	Schistoc. dimorphus	Loennberg	1890 : 18.
1893	Schistoc. dimorphus	Olsson	1893 : 15.
1896	Schistoc. dimorphus	Ariola	1896 : 280.
1896	Bothriocephalus zschokkei	Fuhrmann	1896.
1898	Schistoc. zschokkei	Fuhrmann	1898 : 144.
1898	Schistoc. solidus	Muehling	1898 : 33.
1899	Schistoc. nodosus	Luehe	1899 : 52.
1900	Schistoc. dimorphus	Ariola	1900 :426

1910	Schistoc. gasterostei	Luehe	1910 : 19.
1911	Schistoc. dimorphus	Solowiow	1911 : 123.

Specific diagnosis: With the characters of the genus. Medium sized worms, length 30 to 300mm., breadth 3 to 9. First segment or "scolex" 0.4 to 0.8mm. in length and 1.0 to 1.3 in width. Strobila ovate-lanceolate and depressed, maximum breadth anterior to the middle; hindermost segments narrower and flatter, 0.25 to 1.0 mm. in length by 1 to 3 mm. in width, forming an appendage up to 10mm. in length; medium segments 0.1 to 0.5mm. long, posterior borders prominent. Shallow median groove on the ventral surface.

Cuticula 15 to 20μ in thickness; subcuticula 40 to 65μ. Layer of internal longitudinal muscles 15 to 50μ in thickness. Nerve strands 30 to 75μ in diameter. 25 to 30 excretory vessels in transections.

Genital cloaca median, shallow, with a diameter of 90μ; no hermaphroditic duct. Opening of vagina close behind that of cirrus and to one side but not so far as that of the uterus, both alternating irregularly from side to side.

Testes extend from the median genital ducts laterally to the edges of the medulla, unbroken from proglottis to proglottis, closely crowded, 240 to 480 in number for each proglottis, 85 to 100μ in depth, 40 to 65 in width and 55 to 85 in length. Vas deferens median, dorsal, closely applied to the seminal vesicle, the whole mass 0.30mm. in diameter, the duct itself 35 to 60μ. Seminal vesicle 175 x 150μ, walls 25μ in thickness. Cirrus-sac oval in shape, immediately below the seminal vesicle, 0.185 - 0.205 x 0.203-0.212 x 0.166-0.185mm. in dimensions. No inner seminal vesicle. Cirrus

proper not sharply separated from the ductus ejaculatorius; whole surrounded by numerous retractor muscles.

Vagina 45 to 60μ in diameter just within the medulla. Receptaculum seminis large, 92-104μ in diameter. Spermiduct unites with the oviduct close to the ventral wall of the medulla. Ovary with large wings consisting of closely arranged tubules, whole organ 0.6mm. in width, wings 0.10 in length. Ova 15μ in diameter, their nuclei 5μ. Oöcapt 35 to 40μ in diameter, oviduct 25 to 30μ. Vitelline gland unbroken at margins of the proglottis, from proglottis to proglottis and medially, excepting for small areas above and below the proximal reproductive ducts; individual follicles 55-90 x 18-26μ. Ootype 16-20μ in diameter. Shell-gland slightly to one side of median line. Uterus 85-135μ in diameter at its middle; the terminal portion directed dorsoventrally and lined with cuticula distally; opening at the bottom of a slight invagination of the ventral body wall, formed by the rupture of a preexisting cuticular membrane.

Eggs, 38-65 x 22-58μ.

Habitat: As larvae in the body-cavities and occasionally in the stomach and intestine of bony fishes; adults in the intestines of wading and diving birds.

Host	Locality	Collector	Authority
Larval stage:			
Gasterosteus aculeatus	--------	Frisch	Diesing 1850:584.
" "	Greenland	Fabricius	Fabricius 1780:320.
" "	----------	Rudolphi	Rudolphi 1810:58.
" "	Gryphswald & Berlin	"	" 1819:140.

? *Gasterosteus aculeatus*	--------	Baer	Diesing	1850:584.
? " "	-----------	Creplin	"	" "
" "	Bracciano, Italy	Parona	Parona	1899:8.
" "	Rome	Vinciguerra	"	" ".
" "	Loch Loriston, Cove, Scotland	H.C.Williamson	Scott	1909:80.
" *pungitius*	-----------	Frisch	Diesing	1850:584.
? " "	-----------	Baer	"	" ".
? " "	-----------	Creplin	"	" ".
Cottus scorpio	-----------	Zoega	Rudolphi	1810:58.
" *poecilopus*	L. Storsjön, Sweden	Olsson	Olsson	1893:15.
" *bairdii*	Swan R., Mont.	Everman	Linton	1897:427.
Salmo salar	-----------	Mueller	Rudolphi	1810:58.
" "	Gryphswald	Rudolphi	"	1819:140
" "	Basel	Zschokke	Zschokke	1896:776
Totanus calidrus	-----------	Creplin	Diesing	1850:584
Fulica atra	-----------	"	"	" "
Phoca vitulina	Gryphswald	Rudolphi	Rudolphi	1819:140
Rhynchichthys gon gronovii	Hayti	Weinland	Diesing	1850:585
Rana esculenta	-----------	-----------	Luehe	1910:19
Gasterosteus bispinosus atkinsii	Chamcook L., New Brunswick	Cooper	Cooper (the present paper)	
Uranidea formosa	Port Credit, Ontario.	"	"	

Adult stage:

Corvus corax	------------	Schilling	Diesing	1850:584
" *cornix*	East Prussia	Braun	Muehling	1898:34
Recurvirostra avocetta	------------	Schilling	Diesing	1850:584

Ardea cinerea	------------	Braun	Diesing	1850:584
" "	------------	Abildgaard	Rudolphi	1810:54
" stellaris	Genf	Fuhrmann	Fuhrmann	1896:546
Ciconia nigra	------------	Schilling	Diesing	1850:584
" alba	East Prussia	Braun	Muehling	1898:34
" ciconia	------------	------------	Luehe	1900:19
Sterna hirundo	Gryphswald	Rudolphi	Rudolphi	1819:140
" arctica	------------	Schilling	Diesing	1850:585
" nigra	------------	"	"	" "
" macroura	Gryphswald	Mus. Zool. Gryphswald	"	" "
" minuta	"	"	"	" "
Colymbus septentrionalis	"	Rudolphi	Rudolphi	1819:140
" "	------------	Creplin	Diesing	1850:585
" "	Pillau	Muehling	Muehling	1898:33
" "	Firenze, Italy	Condorelli	Parona	1899:8
" cristatus	Gryphswald	Rudolphi	Rudolphi	1819:140
" glacilis	------------	Abildgaard	Diesing	1850:585
" immer	------------	"	Rudolphi	1810:54
" troile	------------	"	"	" "
" arcticus	------------	Schilling	Diesing	1850:585
" griseigena	------------	------------	Luehe	1910:19
Podiceps cristatus	------------	Rudolphi	Diesing	1850:585
" "	? Pillau	Muehling	Muehling	1898:34
" rubricollis	------------	Nitzsch	Nitzsch	1824:98
" nigricollis	Bracciano, Italy	Parona	Parona	1899:8
" "	------------	Solowiow	Solowiow	1911:123

Larus capistranus	------------	Schilling	Diesing	1850:585
" ridibundus	------------	Siebold, Coll. Brit. Mus.	Baird	1853:98
" "	Rossitten	Muehling	Muehling	1898:34
" marinus	Pillau	"	"	" "
" argentatus	-----------	-----------	Luehe	1910:19
" "	-----------	Siebold	Moniez	1881:175
Anas glacialis	-----------	Creplin	Diesing	1850:585
Mergus albellus	-----------	Bloch	"	" "
" "	-----------	Schilling	"	" "
" merganser	-----------	Bloch	"	" "
" "	-----------	Schilling	"	" "
" "	Pillau	Muehling	Muehling	1898:33
" serrator	-----------	Abildgaard	Rudolphi	1810:54
" "	-----------	Creplin	Diesing	1850:585
" "	? Glasvaer, Norway	Loennberg	Loennberg	1890:18
" "	L. Storsjön, Jemtland, Sweden	Olsson	Olsson	1893:15
" "	? Pillau	Muehling	Muehling	1898:34
Uria troile	------------	Abildgaard	Diesing	1850:585
" grylle	------------	Schilling	"	" "
Alca pica	------------	"	"	" "
" torda	Leipzig	C. W. Stiles	Stiles and Hassall	1894:322
Totanus calidrus	Jaederen, Norway	Loennberg	Loennberg	1890:18
Harelda glacialis	Pillau	Muehling	Muehling	1898:34
Fuligula marila	"	"	"	" "
Haematopus ostrealegus	"	"	"	" "

Fulica atra	Portoferrajo, Id.Elba	Damiani	Parona	1899:7
Puffinus kuhli	"	"	"	" "
Urinator arcticus	------------	------------	Luehe	1910:19
" imber	------------	------------	"	" "
" stellatus	------------	------------	"	" "
Stercorarius parasiticus	------------	------------	"	" "
Nyroca marila	------------	------------	"	" "
" hyemalis	------------	------------	"	" "
Lophodytes cucullatus	Lincoln,Nebr.	H.B.Ward	Cooper (the present paper)	

As indicated in the above synonymy, this species was known for almost a century, at first as the larval form only and then as both larval and adult forms, before it was discovered that the two species recognized from the time of Bloch (1783) were one and the same. Abildgaard (1790), who called the work _T. gasterostei_, seems to have been the first to consider the larval form found chiefly in stickle-backs to be the same as that found in fish-eating birds, since on feeding stickle-backs infected with the larvae to geese he obtained the adult form from the intestines of the latter. Yet Rudolphi (1810) did not agree with his conclusions but still considered that there were two distinct species, namely, _Bothriocephalus nodosus_ (adult) and _B. solidus_ (larva). And this continued until Creplin (1829) united both in one species under a new genus, _Schistocephalus dimorphus_. Diesing (1863: 233) made a new species out of the _Schistocephalus_ found by Weinland (1859) in the Island of Hayti in _Rhynchichthys gronovii_, but later writers have considered that in all probability it was only the well know larval form of this species. Willemoes-Suhm (1869) was evidnntly the first to study the development of the fertilized ovum which was later gone into more thoroughly by Schauinsland (1885 : 555). Donnadieu (1877) to whom all go back in their considerations of the larval development of Ligula, unfortunately fell into the error of considering _Schistocephalus_ and _Ligula_ to be not only the same specifically but generically. The anatomy was first studied by Moniez (1881 : 175), more thoroughly by Kiessling (1882) and still later by Fuhrmann (1896) (under _B. zschokkei_ sp.nov.) and Solowiow (1911). Linton (1897 : 427) is the only one, apart from

Weinland's record which the writer was not able to locate, who has reported the species from America.

As regards the correct name of the species it should be noted that, altho Luehe (1899 : 53) called the "typical and only species" of the genus <u>Sch. nodosus</u> (Rud.) and the larval stage <u>Sch. solidus</u> (O. F. Mueller), he reverted in 1910 to "<u>Schist. gasterostei</u> (<u>Fabr</u>.) (= <u>Sch. dimorphus Crepl</u>.)" without, however, discussing the change. But according to the Rules of Nomenclature, Art. 27 (b), the earliest name of the larval stage must hold, so that, since Luehe himself considered this to be <u>Sch. solidus</u> (O. F. Mueller), the writer makes use of the latter in the present paper.

According to Luehe (1910 : 19)<u>Sch. solidus</u> ranges in length from 30 to 300mm. while the maximum breadth varies from about 3 to 9mm. and is located ahead of the middle of the strobila. As shown in the table below the largest and only sexually mature specimen of the six studied by the writer (vide infra) was only 29mm. in length by 6mm. in breadth. The scolex (Fig.7) is, as indicated in the above diagnosis of the subfamily, not separated from the first segment into which it runs insensibly, the whole "head" being thus triangular in shape. The bothria are merely short median grooves which unit at the very tip not only with each other but with a frontal median groove which passes laterally into slight emarginations of the edges of the segments. While these emarginations were seen by the writer to be present in the anterior segments, gradually disappearing towards the middle of the worm, no such "flat leaflike flaps (bothria) on the lateral margins,

separated from each other on flat surface by a broad, shallow sulcus," as described by Linton (1897 : 428) and shown in his Fig. 4, Pl. XXVIII, for the first segment were met with, but the posterior border was quite entire, altho, as seen in Fig. 7, not very prominent in the vicinity of the median line in adults as well as in larvae. The bothria of the mature specimen (H 7 of the table below) were not present, but the region where they would otherwise be was seen to be quite smooth, only a shallow, median frontal groove appearing. The whole strobila is ovate-laceolate, considerably depressed and provided in the adult with a very shallow median groove on the dorsal surface (Fig. 9) which seems to be due to the slight protrusion of the median reproductive organs, chiefly the cirrus-sacs and seminal vesicles, towards the ventral surface (Fig. 8) and the consequent dragging downward of the dorsal median tissues. Concerning this matter Linton said that "S. dimorphus is described as having in the larval state a longitudinal median furrow on each face. These specimens do not exhibit this character; neither do they have anything that can be properly called a costa dividing the two bothria." While in the specimens studied the dorsal groove was present not only in the adult but (not so well marked) in the larva, a similar ventral groove was also noticed in sections of the anterior end of one of the latter. Both grooves, however, are in any case so shallow as to be easily overlooked in alcoholic specimens; they seem to be of only secondary importance since they are apparently quite variable in their nature. While the segments in the anterior region of the strobila are very broad and comparatively thick, short, and

from 0.1 to 0.5mm. in length, posteriorly the strobila is considerably smaller and flatter, especially in mature individuals, but even in larvae the segments being much more irregular in outline and as much as 1mm. long (0.75 in the only ripe specimen studied). The segmented condition of the strobila, in contrast with that of Ligula, is rendered more apparent by the prominent posterior borders of the anterior and middle proglottides which at the margins produce the characteristic saw-tooth effect. The following table gives the measurements of two specimens with those by Linton for comparison:

Number	72	H.7	4727, U.S.N.M.
Length	17mm.	29mm.	32mm.
Max. breadth	5.5	6	6
Length of "Cauda"	1.64	10	?
Breadth of same	1.1	2-3	2.5
Med. segs., length	0.16	0.27-0.46	0.25
Post. segs., "	0.25-0.40	0.40-0.75	?
First seg., "	0.46	0.46	0.80
Breadth anteriorly	0.48	0.46	0.80
" posteriorly	1.11	1.11	1.30
Length of bothrium	0.074	Absent	?
Condition	Larval	Adult	Larval

Since the essential features of the internal anatomy of this species have been worked out by the European workers, only the striking similarities and differences to and from the data given in particular by Kiessling, Fuhrmann and Solowiow will here be dealth with in support of the writer's contention, in the ab-

sence of European material for comparison, that here in America we have the same species as that found in Europe. And it will be considered that, as brought out by Luehe in his three controversial references (1897b and 1899a : 715) and by Cohn (1898 : 126, footnote), S. zschokkei Fuhrmann 1898 issynonymous with S. solidus, since many of the data given below will be seen to compare more favorably with those published by Fuhrmann than with those by either Kiessling or Solowiow.

According to Kiessling thecuticula is from 15 to 18 μ in thickness and divisible into two layers, of which the inner and lighter is from 8 to 9 μ thick, while the outer is striated or granular. Fuhrmann described a cuticula only 7 μ in thickness and divided into two layers, and Solowiow gave the thickness of the "homogeneous cuticula" as 23 μ, but Minckert (1905a : 402) said that the comidian or pseudociliated layer, present in many bothriocephalids, was quite evident in S. nodosus but absent on the posterior borders of the proglottides. Here the cuticula was found to be 15 μ in thickness, excepting on the posterior borders where it was only 5 μ , and to be divisible into two layers, the outer of which, a little thinner than the inner, was much lighter, granular in consistency or somewhat striated with, however, a more or less uniform external boundary. It seems to be easily separated from the inner stratum, the bounding line, in reality the innermost portion of the external layer, being in most places very light. In fact the brightness of this inner layer of the outer stratum indicates the degree of separation of the two layers in the process of sloughing off the outer, which can be easily

followed in sections as described by Kiessling. But this description applies only to the adult stage, for in larvae the cuticula, altho of the same thickness, shows an outer decidedly pseudociliated layer only 4 μ in depth. The subcuticula, 88.5μ in thickness in the median line according to Solowiow, was found to be from 40 to about 65 μ, Kiessling having given the limits as from 29 to 38 μ. While the parenchyma is, as described by the authors, very fine meshed, calcareous bodies are present in comparatively small numbers, particularly just beneath the subcuticula of the larva. Their maximum dimensions were found to be 23 x 13μ.

The musculature has been well described by Kiessling and Fuhrmann, so that it needs only to be said that in sections of mature proglottides the writer found that the outermost layer of transverse muscles as well as the outer longitudinal layer were much less numerous and hence well defined than in the larva. Whereas Kiessling gave the thickness of the external and internal longitudinal groups, which on account of their compact nature were found to be more uniform in thickness than the transvers layers, as 8-33 and 16-49μ, respectively, and Fuhrmann as 4 and 8 μ, the writer found them to be 17 and 30-40 μ.

The nerv ous system was first studied in detail by Niemiec (1888 : 9) and later more thoroughly by Cohn (1898 : 126) who summarized its structure in the following words: "Von dem vordersten Theil, den Ganglien und der Commissur, ziehen die Hauptstränge und 12 Nebennerven rückwärts (six associated with each chief strand). Die Nebennerven theilen sich dichotomisch in zwei Ebenen, der

frontalen und radiaren, ein Theil des Theilfasem rückt zwischen äussere Transversal und Längsmuskeln, der andere bleibt weiter nach innen zu zuruck, und diese Nerven treten einerseits unter einander durch Ringcommissuren, andrerseits durch radiäre Fasern mit den Hauptnerven in Verbindung." Whereas Kiessling gave the diameter of the chief nerve strands as 38 μ and Solowiow as 67.9 μ, here they were found to be from 30 in mature proglottides, to 75μ in the anterior segments. The ganglia were found to have a diameter of from 55-85 μ, compared with 77 μ by Kiessling.

In transections from 25 to 30 excretory vessels were seen in the medullary parenchyma with diameters ranging from 29 to 63 μ. Fuhrmann gave 24 as the number while Solowiow gave their size as 13.9 to 33.3 μ. Foramina secundaria are to be seen piercing the cuticula here and there, but they are not very numerous.

As indicated in the diagnosis of the subfamily the reproductive organs appear close behind the scalex. In one toto preparation of a larval specimen, No. 73 of the above table, the earliest traces of their rudiments were present in the 18th proglottis, or 3.96mm. from the anterior end, while in the only mature specimen, H.7, they were in the 16th proglottis, a few eggs appearing in the uterus of the 17th. The cirrus and vagina were found to open close together in a very shallow and sometimes quite obliterated genital cloaca. With a maximum diameter of about 90 μ, the vagina behind the cirrus, but very slight either to the right or left and not according as the uterine opening further back likewise alternates irregularly but with a greater amplitude. The three apertures form almost a right-angled triangle, as described

by Kiessling, but, as was pointed out by Luehe (1898a :716) this arrangement is by no means constant but varies with the state of contraction or relaxation of the whole strobila and hence cannot be considered as specific.

The testes are arranged in a single layer in the dorsal portion of the whole of the medulla not only in the larval but also in the adult, as described by Fuhrmann, the majority of the excretory vessels being situated towards the ventral side of the medulla, and are absolutely continuous from proglottis to proglottis. Their number in transections is from 30 to 40 (30-35, Kiessling) and in sagittal from 8 to 12 for each proglottis, thus making the total from 240 to 480 or over 300 on the average, which stands in distinct contrast with the number of about 100 given by Fuhrmann. The latter gave their dimensions as 80 x 34 μ, Kiessling as 16 to 66 μ in young and 149 in mature animals, and Solowiow as 63-33 μ; while the writer found them to be from 85 to 100 μ in depth, 40 to 65 in width and 55 to 85 in diameter in frontal sections. They are very closely crowded together in the proglottis. The vas deferens forms a compact mass of coils situated in the median line dorsally and slightly posterior to the vesicula seminalis to which it is closely applied as a sort of cap. While the diameter of the whole organ is about 0.3mm. that of the duct itself is from 35 to 60 μ when distended with spermatozoa. Kiessling gave its diameter as 38 μ, and Solowiow as 16.3. The large thick-walled seminal vesicle (Fig. 9) situated immediately above the cirrus-sac was found to have a maximum depth of 175 μ and transverse diameter of 150 μ , as compared with the 92 μ of Kiessling and the

80 μ of Fuhrmann. Its walls are very muscular, about 35 μ in greatest thickness and covered both internally and externally with numerous nuclei which are respectively epithelial and parenchymatour or myoblastic in their nature. Within the cirrus-sac the vas deferens is much coiled but not enlarged to form any secondary vesicle nor sharply separated into an ejaculatory duct and cirrus proper. The sac itself is oval in shape, the ventral end being the smaller, and the proximal end somewhat invaginated by the seminal vesicle. Its size is shown in the following table:

	Kiessling	Fuhrmann	Solowiow	The writer
Depth	0.347mm.	0.25mm.	0.204mm.	0.185-0.203mm.
Width	0.192 "	0.13 "	0.174 "	0.203-0.213 "
Length	...	...	...	0.136-0.185 "

Its wall, about equal in thickness to that of the seminal vesicle, is, however, more open in texture, the myoblastic nuclei of the obliquely arranged muscle fibres being scattered thruout its diameter (Fig. 9). It is, furthermore, not sharply separated either externally or internally from the surrounding parenchyma and the numerous stout retractor muscles of the cirrus, respectively. The latter, in fact, constitute practically the whole of the contents of the sac apart from the duct itself. The only protruded cirrus seen had a length of 70 μ, as compared with the 0.3945mm. given by Solowiow.

The vagina, the opening of which is usually situated about 50 μ from that of the cirrus at the bottom of the shallow genital cloaca, above mentioned, has a diameter of from 45 to 60 μ

at the first bend in its course within the medullary parenchyma. Soon after it enters the latter it becomes thin-walled, as pointed out by Fuhrmann, owing to the thinning out of the cuticula and the substitution of the proximal nucleated epithelium for the same, altho more peripherally much flattened nuclei are to be seen beneath the cuticula and crowded close to the basement membrane. In other words the gradual replacement from within outwards of the cuticula for the original epithelium may be followed very easily in the walls of the vagina. The duct gradually enlarges to form a much elongated receptaculum seminis (Fig. 8) with a diameter of 92-104 μ. (9-31 μ, according to Kiessling!) and sharply separated from the spermiduct, which, however, was not found in the sections made to unite with the oviduct close to the dorsal transverse musculature as stated by Fuhrmann, but close to the ventral wall of the medulla. The ovary consists of two large wings (Fig. 8), composed of closely crowded tubules, lying immediately upon the ventral transverse muscles and united by a much smaller isthmus, the whole having the width of 0.64mm, as compared with the 0.28mm. of Solowiow. The average length and depth of the wings are, respectively, 105 and 90 μ. Ova from the isthmus and more median portions of the wings of the ovary were found with a diameter of 13 μ while their nuclei were 5 μ. The respective measurements by Kiessling and Solowiow were 9 and 6 μ and 13.9-23.3 and 1.5-3 μ. Fuhrmann stated that one of the most important differences between his Sch. Zschokkei and Sch. solidus was the presence in the former of an ootype, but Luehe (1899a : 717) claimed that this structure was in all probability overlooked by Kiessling. It arises from the

posterior aspect of the isthmus almost in the median line with a diameter of from 35 to 40μ. The oviduct, according to Kiessling has a diameter of 13μ or to Solowiow of 27μ; here it was found to be from 25 to 30 μ between the entrance of the vagina and that of the common vitelline duct, which two points are close together as in L. intestinalis. The common vitelline duct was found enlarged some little distance from its opening into the oviduct to form a vitelline reservoir having a diameter of 30μ (33μ, Kiessling). The vitelline follicles are extremely numerous and closely crowded together in a layer with a maximum thickness of 85μ situated between the inner longitudinal and middle transverse muscles (Fig. 8). They are continuous at the margins of the proglottis, as they are from joint to joint, and broken only in limited elliptical areas above and below the reproductive ducts in the median line, as stated by Fuhrmann. The size of the individual follicles is according to Kiessling 56-107 x 56μ and to Solowiow 18 x 27μ; here they were found to be 38-87 x 18-36μ, the larger dimensions being the dorsoventral diameters. Just beyond the entrance of the common vitelline duct the oviduct enlarges to form the ootype with a diameter of 16μ (20 μ, Kiessling) and surrounded by the shell-gland which is situated just above the median frontal plane and somewhat lateral. Thruout its course the oviduct is lined with an epithelium in which prominent nuclei but no distinct cell boundaries were seen and from which numerous cilia protrude into the lumen. In the ootype these cilia are much more noticeable. From the ootype the oviduct passes ventrally with a few coils then across the median line close above the receptaculum seminis as the beginning

of the uterus. The latter gradually enlarges as it passes forward while crossing the median line several times, until at about the middle of its course it has a diameter of 85 to 135 μ. As regards the terminal portion of the tube the writer found that, as Fuhrmann observed: "Der Endtheil der Uterus verengert sich und verläuft von der Dorsalfläche (the median frontal plane in which the last transverse coil is situated) direkt ventral, um regelmässig abwechselnd links oder rechts neben der Vagina auszumünden" (vide supra).

Sections show that the actual opening is formed by the rupture of the bottom of a cup-like invagination of the cuticula from the ventral surface, which meets the end of the duct with a diameter of from 25 to 40 μ. As Fuhrmann stated, "Dieser Ausführgang der Uterus ist von der Stelle an, wo er ins Rindenparenchym tritt, wie die Vagina und der Cirrusbeutel, von zahlreichen Parenthymuskeln umhüllt und von einer der Körpercuticula ähnlichen membran ausgekleidet," but the cuticula was found as such only near the opening, since only halfway back along this dorsoventral limb of the organ flattened nuclei could be distinctly seen. In other words the flattened epithelium of the uterus, which showing only a few scattered nuclei was described by Kiessling as a "fine, structureless but elastic membrane" passes insensibly into the cuticula near the opening, no distinct line of junction between the two being discernible, which latter is also applicable to the similar structure of the vagina.

The dimensions of the ellipsoidal eggs in the sections of the uterus were found to be 62-65 x 33-36 μ. Kiessling gave them

as 49 x 37 μ and Fuhrmann as 70 x 29 μ, but in discussing the latter Luehe (1899a : 718) remarked that not only did he find variations from 38 x 22 to 56 x 38 μ in the size of the eggs in material of B. zschokkei sent to him by Fuhrmann, but that in general even greater variations than these are to be found in other species according to the various writers.

Our knowledge of the life-history of this species dates from the time of Abildgaard (1790) who, was mentioned above, was the first to experiment with the larval individuals found in fishes. Creplin (1829) united the two forms which were considered to be two separate species into one species, evidently on the basis of the previous work, especially Abildgaard's (cf. Donnadieu, 1877f : 340-341), while Donnadieu in his elaborate experiments on the life history of Ligula unfortunately did not differentiate between it and Schistocephalus. The development of the fertilized embryo into the oncosphere was first studied by Willemoes-Suhm (1869) and later more in detail by Schauinsland (1885 : 555), since when nothing of special importance has been added so far as the writer is aware. Hence up to the present we know no details of the development of the oncosphere into the larva in the intermediate host, as is the case with most of the bothriocephalids.

As regards the identity of the material studied with the European species it will be seen from the above comparisons that, while there are many discrepancies among the data given by Kiessling, Fuhrmann and Solowiow, those by the latter departing the farthest in many respects, the resemblances so outweigh the differences as to make the erection of a new species unjustifiable.

The thickness of the cuticula, the diamter of the excretory vessels, the dimensions of the seminal vesicle, the ovary and the eggs, which constitute the majority of the differences, might easily be explained by differences in age of the material studied, but the number of testes (100) as given by Fuhrmann can scarcely be reconciled with that as given by the writer (300+), altho his dimensions of the organs agree with those given here perhaps better than do those by Kiessling or Solowiow. On the other hand we must bear in mind other facts which doubtless in the long run are more important than a comparison of the details of tha anatomy of this evidently highly variable species, namely, the geographical distribution of the hosts. Altho we cannot place so much emphasis on Fabricius' finding T. gasterostei in the type larval host as long ago as 1780 in Greenland, we must remember that here in America there are, as in the case of L. intestinalis, not only a number of the same genera but also of the same species of the larval as well as the adult host as in Europe, so that from this alone we would be justified in expecting to find the same species of Schistocephalus, especially since it infests such a number of different host species. But, on the other hand, it is a very surprising fact that apart from Linton's report of the larva from Montana evidently no one has up to the present found the form in any of the numerous fish-eating birds of the continent.

This evident infrequent occurrence of the species is illustrated by the fact that the material used for study by the writer consisted of only four lots: Nos. 61b and 72 from the body cavities of Uranidea formosa, taken from the stomach of Lota maculosa, and

190 from the coelome of Gasterosteus bispinosus atkinsii, of the writer's collection; and No. 17.192 of the C. U. Ill. from the intestine of Lophodytes cucullatus, the only mature specimen available, — in all only six specimens.

Subfamily 2. HAPLOBOTHRIINAE subfam. nov.

Strobila formed by the subdivision of the segments of a primary strobila. Scolex of the latter a cylindrical, somewhat clubshaped organ bearing four eversible proboscides similar in structure to those of the Trypanorhyncha; scolex of the former or secondary (definitive) strobila merely the slightly modified foremost segment, provided with shallow dorsoventral depressions analogous to the bothria of other bothriocephalids. An elongated neck may be said to be present in the primary strobila. Segmentation of the primary strobila resulting in the formation some distance behind the scolex of a comparatively small number of long narrow segments which in turn subdivided anteriorly to form the segments of the secondary or final strobila. Segmentation in the latter thus beginning immediately behind the secondary scolex, but complete in its anterior region only. Genital organs simple in each proglottis. Genital openings surficial, ventral and median as in the Diphyllobothriinae. Ovary and shell gland median, respectively ventral and dorsal. Vitelline follicles in the medullary parenchyma, as are the testes, both within the nerve trunks. Testes separated into two lateral fields by the median excretory vessel and the genital organs in the median line. Vas deferens enlarged to form a large non-muscular seminal vesicle before entering

the cirrus-sac. Cirrus armed with minute spines. Receptaculum seminis medium sized, sharply separated from the spermiduct. Uterus divided into a much coiled proximal uterine duct and a large uterus-sac, as in the Ptychobothriidae.

Type genus: Haplobothrium Cooper

Altho we know as yet comparatively little about the life-histories of the bothriocephalids, the definitive scolex and strobila develop directly from the larval stage, known as the plerocercoid, present in the intermediate host. This is certainly the case with Ligula, Schistocephalus, Diphyllobothrium latum, Cyathocephalus truncatus and Triaenophorus. As a matter of fact in all of these the scolex is already more or less well formed before the larva reaches the final host, while the plerocercoid continues to grow and soon shows the beginnings of segmentation which marks the young strobila. Consequently the writer feels that we must look upon what is called here the primary strobila of Haplobothrium as the true strobila, homologous with the young strobila of other bothriocephalids, altho what was formerly considered to be the strobila is quite similar, apart from the absence of external segmentation in its posterior region, to that of other members of the order. Even tho it is provided with a very aberrant scolex region, -- and we must remember that the scolex is no more sharply set off from the rest of the larva in other species, such as D. latum, -- the young and as yet unsegmented primary strobila may be considered to be a typical plerocercoid.

The nerv ous system consists of two chief strands united

anteriorly by a commissure, which is doubtless relatively larger than in other forms on account of the neighboring proboscides to which it sends large branches, as in the larvae of Ligula and Schistocephalus, for instance. Its excretory system is likewise built on the typical plan, the posterior connections with the exterior being, in fact, quite like those of B. scorpii. On the other hand, it can be seen from the description of the development given below that the terminations of the nervous and excretory system in thesecondary strobila, both anterior and posterior, support the view that the latter is not homologous with the strobila of other bothriocephalids. For what was formerly described as the ring Commissure must now be considered as merely a secondary development due to the fusion of the severed ends of the chief strands, which statement is also applicable to the terminal vesicle of the excretory system. And this in spite of the fact that the secondary scolex is quite similar to the true scolex of other species in that it is supplied with two sets of muscles which are not found in the foremost segments but are peculiar to the scolex. Since there is considerable evidence in the literature of cestodes to show that the prominent posterior borders of the foremost segments of many species are developed as accessory organs of attachment or for locomotion (cf. Spengel, 1905 : 281), we might well ask ourselves whether external segmentation in Haplobothrium, particularly since it is confined to the anterior region of the secondary strobila, is palingenetic or coenogenetic in its nature. The facts that no such appendages are present in the primary strobila and that the posterior end of the secondary one is non-segmented apart from

the sets of reproductive organs, would seem to point to the original condition being one in which external segmentation was absent as in Ligula or Triaenophorus. Since, however, in the middle region of the secondary strobila there is an actual correspondance between the external and the internal segments, it is quite probable that the external segmentation is much older than might at first appear, while the ligulate condition of the posterior end may have developed secondarily. And we must remember, too, in this connection that, according to Lushe (1898 : 285) Ligula has descended from fully segmented bothriocephalids.

As regards the remaining characters of the subfamily the writer met with not a few difficulties on account of the fact that up to the present there is only one genus and one species known. Those given are consequently based on a comparison of the species with the neighboring subfamilies and in particular with the Diphyllobothriinae to which it is most closely related. It differs from the Diphyllobothriinae, however, in that the genital organs are simple in each proglottis; the vitelline follicles are medullary; the testes are within the nerve trunks; the seminal vesicle is not strongly muscular; the cirrus is armed with minute spines; the receptaculum seminis is medium sized; while the uterus is divided into uterine duct and uterus-sac as in the Ptychobothriidae.

Genus 1. <u>Haplobothrium</u> Cooper 1914 e.p.

<u>Haplobothrium</u> Cooper 1914b : 1-2

<u>Haplobothrium</u> Cooper 1914b : 115

Borders of the terminal disc of the secondary scolex and of the posterior auricular appendages of both the scolex and anterior segments provided with minute spines which disappear with the appendages farther back. Nervous system consists of two chief strands situated in the medullary parenchyma outside of the vitelline follicles, uniting inthe anterior end of the secondary strobila to form a secondary nerve ring, and eight collateral strands, four arranged around each main tract, the latter in the jointed portion of the strobila only, but in the true scolex to form an irregular transverse commissure situated among the proboscides. Excretory system composed of one large median and slightly dorsal vessel and two smaller lateral and ventral, all uniting in the secondary scolex behind the nerve ring to form a vesicle. No genital cloaca, opening of vagina close behind that of cirrus, towards the anterior end of the proglottis, that of the uterus much farther back. Sphincter vaginae present. Vitelline glands in numerous follicles arranged cylindrically around the testes, both continuous from joint to joint, leaving clear areas opposite the central genital ducts; large vitelline reservoir. Vas deferens provided with a sperm-reservoir at its posterior end near the middle of the proglottis; whole course of the duct dorsal to the uterus-sac. Uterus-sac when gravid occupies the whole of the middle of the proglottis.

Type species: <u>H</u>. <u>globuliforme</u> Cooper

The characters here given are in reality those of major importance in the species left after what are considered by the writer to be subfamily characters are removed. The difficulties in defining the genus are great owing to the facts that it stands alone in the subfamily, contains only one species and is, furthermore, so aberrant in many respects.

Haplobothrium globuliforme Cooper 1914.

1914 Haplobothrium globuliforme Cooper 1914a : 2

1914 Haplobothrium globuliforme Cooper 1914b : 115.

Specific diagnosis: With the characters of the genus. Small worms, primary strobila up to 70mm. in length, secondary to 110mm., with respective maximum breadths of 0.3 and 0.6mm. Primary scolex 0.35mm. in diameter, indefinite in length, bulbs 0.40-0.45 x 0.06 x 0.07mm.; secondary scolex, 0.4-0.5 x 0.25-0.4mm. Auricular appendages disappear at about the 25th segment in normal secondary strobilas. Foremost secondary segments tetragonal, middle and posterior much elongated and considerably depressed.

Cuticula 3-4 μ in thickness, subcuticula 25 μ. Chief nerve strands 18 μ in diameter, narrowing intersegmentally. Terminal excretory vesicle 20-40 μ in diameter.

Genital organs begin at about the 15th proglottis. Openings of cirrus and vagina 0.02-0.07mm. apart.

Testes spherical to ellipsoidal in shape, 70-115 μ in maximum length; 80 in each segment. Vas deferens median, elongated, only slightly coiled, 10-55 μ in diameter. Vesicula seminalis broadly spindle-shaped, 140 x 90 μ. Cirrus 20-30 in diameter;

cirrus-sac, 0.16-0.21 x 0.14-0.16 x 0.18-0.20mm.

Vagina 20-30 μ in diameter at its opening, 56μ in its enlarged distal portion. Receptaculum seminis 30-45 μ in diameter, spermiduct 5-10 and very muscular. Ovary hippocrepiform, the limbs being directed posteriorly and often fused with each other, the isthmus narrow. Ova from latter 10-12 μ in diameter, their nucleu, 7 μ. Oocapt 15 to 25 μ in diameter, oviduct 8-15 μ. Two vitelline ducts, each 6 μ in diameter; vitelline reservoir 22 to 55 μ; follicles spherical ~~in~~ ellipsoidal in shape 8-50 μ in diameter, very numerous and closely crowded. Ootype 20 μ in diameter; shell-gland irregular in shape, poorly developed. Uterine duct enlarged proximally with few coils, smaller distally and more coiled, median, 25 to 55 μ in diameter; uterus-sac elongated, filling most of the medulla when granid; uterus opening a small median elongated slit, situated near the posterior end of the sac. Eggs, 60-70 x 40-43 μ.

Habitat: In the intestine of the host.

<u>Host</u>	<u>Locality</u>	<u>Collector</u>	<u>Authority</u>
<u>Amia calva</u> (type host)	Go-Home Bay Muskoka, Ontario	Cooper	Cooper, 1914b : 31
" "	Havana, Illinois	H. B. Ward	Cooper (the present paper)
" "	Fairport, Iowa	"	"

Type specimen: No. 33.1 in the writer's collection.

Co-types : Nos. 33.2 and 33.3 of the same, and in the Coll. Univ. Ill.

In a preliminary paper on the systematic position of this species the writer (1914 : 1) described the scolex as " ... unarmed, although the edges of the terminal disc and auricular appendages of both scolex and anterior proglottides are provided with very minute spines. Bothria, two shallow depressions on the dorsal and ventral surfaces, very simple in structure," and in the detailed description which followed (1914b) the organ was dealt with (p. 88) as follows: "The scolex is quite small, simple externally and with the unaided eye can scarcely be distinguished from the first joints. It is shaped roughly like a rectangular solid, hollowed out laterally to form simple depressions and dorsoventrally the shallow bothria or organ of attachment. The summit is somewhat prolonged as a low pyramidally-shaped disc, quite comparable to that ("Scheitelplatte") found in the members of the subfamily Triaenophorinae Luehe 1899 ... The opposite end of the scolex is modified to form two pairs of auricular appendages closely resembling internally as well as externally those of the foremost joints." Furthermore in both papers it was emphasixed that the scolex differs little in structure apart from the nervous and excretory systems from the first segments and that the simple bothria, whence the generic name, seem of little functional importance as compared to those of other species, while the auricular appendages of both scolex and foremost joints with their borders of minute cuticular spines probably act as accessory organs of attachment.

Since then the latter view has been rendered still more highly probable, altho as yet no observations have been made on

the living worms in their relation to the wall of the host's intestine, by the discovery that the so-called scolex (Figs. 13 and 14) is not in reality the scolex but only a slightly modified anterior segment, while the functional scolex is something quite different from anything present in the whole order, so far as the writer is aware.

As shown in Figs. 10, 11 and 13, the scolex consists of the slightly enlarged anterior end of the original plerocercoid or larva from which protrude four proboscides, the whole somewhat resembling a hydra or reminding one of the Trypanorhyncha. And, as will be presently seen, the latter comparison is a very apt one. Each proboscis consists of a permanently protruded base or stump, indicated in Fig. 11, about 85μ in length and 45-55μ in diameter, somewhat conical in shape and thickly set with minute backwardly directed cuticular spines which pass on to the neighboring portions of the end of the larva for a short distance, thru which passes the proboscis proper with about the same diameter. The whole forms at first sight a continuous tentacle gradually diminishing in size to the pointed end. These tentacles attain a length of 0.35mm., including the base, when fully evaginated and are directed almost at right angles to the longitudinal axis of the larva, their bases being however, turned slightly forward (Fig. 11). Within the scolex the tentacles are accommodated in elongated cylindrical muscular sacs, quite comparable in structure to the bulbs of the Trypanorhyncha. These lie freely in the loose parenchymatous tissue in the diagonal diameters of the region. When the proboscides are invaginated, they have a length of 0.45mm. with a diameter of 0.07, or 0.40 x

0.06mm. when the tentacles are protruded. The walls of the bulb (Fig. 17) are composed to two thick layers of muscles, an outer longitudinal or somewhat oblique, much the heavier of the two, and an inner circular lined, lined with a cuticula-like layer, on the inner border of which numerous flattened nuclei appear. The walls are attached to the edge of the stump, and these layers have the same relative arrangement as that of the cuticula and cuticular muscles on the outside of the body, only being in the reverse order. Continuous also with the edge of the stump are the walls of the proboscis proper, which consist of a thin external layer of cuticula and only feeble cuticular muscles. Attached to the walls internally thruout its course are the retractor muscles of the proboscis which pass backward and become attached to the posterior end of the bulb. These can be seen best in longitudinal sections where the proboscis is retracted, for then they are closely crowded and much thicker, and their attachment to the inner end of the proboscis is shown nicely. In the retracted condition the latter is, of course, hollow, the narrow cavity, often triradiate in transection (Fig. 17), being easily followed into the bulb for about one-third of its length. Closely applied to the cuticula of the tip of the proboscis appear in some cases gland-like cells taking the counterstain quite like those behind the bulbs to be described below. They are shown in Fig. 17. Apart from the structures already described, the contents of the bulbs and consequently of the proboscides to a certain extent, consists of a small amount of loose parenchymatous tissue, and what is evidently a good deal of nervous tissue coming into the posterior

end of the organ (vide infra).

Evagination of the proboscides is obviously brought about by the contraction of the muscles in the walls of the bulbs, but the body wall in the vicinity of the latter probably greatly assists, since its muscolature is well developed. Some distance behind the posterior ends of the bulbs the latter consists of a ring-like layer of loosely arranged main longitudinal fibres occupying the middle one-third of the radius of the nearly circular cross-section, no transverse fibres, but comparatively strong cuticular muscles, of which the inner longitudinal layer is the more pronounced. Farther forward this main longitudinal group gradually gives off small fibres towards the cuticula as they themselves diminish in number and size, until at the level of the hinder ends of the bulbs only a few of the latter fibres are left just beneath the subcuticula, while the outer series has formed a compact layer situated close to the longitudinal cuticular fibres (and hence outside of the subcuticular nuclei) but separated from them by a thin stratum of circular fibres. And this continues to the tip of the scolex, most of the remaining inner longitudinal muscles being located at the ends of the transverse and dorsoventral diameters of the transection. In region of the bulbs the body wall is thus quite muscular, and in all probability assists the bulbs in evaginating the proboscides by compressing the whole of the parenchyma surrounding them. Between the bulbs and right beneath the tip of the scolex a few transverse and sagittal fibres are to be found, while just beneath the bases of the stumps of the proboscides the outer longitudinal muscles unite with the longitudinal cuticular

fibres in forming ⌒-shaped loops surrounding the diagonal quadrants of the scolex which accommodate the bulbs. These loops are evidently for the control of the direction of the proboscis stumps.

In working up the original description of this species the writer was at a loss to see how the formation of proglottides could take place continuously since there was considerable evidence to show that only a limited and more or less definite number of segments were present. Concerning the anterior and externally segmented region of the strobila he said: "In many chains this region of the strobila is subject to considerable variation. It was observed that now and then one of the longest proglottides was provided with one or two additional pairs of appendages, generally abortive and situated anteriorly some distance apart. In a few cases staining and clearing brought out a distinct division of the parenchyma, especially posteriorly, in to what seems to be the beginnings of a division of the longer proglottis into several smaller ones. Furthermore in one strobila an undivided region was intercalated between two jointed regions, the second of which was followed by the normal posterior end. Young scolices are shown in Figs. 5 and 6. (In this connection note evidence given below under the excretory system that the latter are incomplete). Although the foregoing facts point to possibly occasional augmentation in the number of proglottides in this region in adult worms, the usual appearances are as described below." And further it was noted that not only do the auricular appendages of the posterior ends of the proglottides disappear at about the same place, namely at about the 23rd or 24th segment, but that "there is

a more or less definite point in the strobila, at or about the 15th proglottis, ahead of which the genital organs do not seem to develop and behind which in older strobilas they appear very quickly." Both of these facts pointed in the opinion of the writer to a more or less definite and predetermined number of segments. Now the matter is cleared up considerably by the discovery that segmentation in this species is carried on after an entirely novel plan, involving the formation not only of new segments but whole chains of them or, in fact, strobilas from the original larval or primary strobila, as the writer will call it.

The original larva (Fig. 10), quite comparable to the bothriocephalid plerocercoid, excepting for the perculiar scolex, gradually elongates with growth, until between a length of 4 and 5mm. the first traces of segmentation appear in the hinder ends of cleared specimens as feeble aggregations of nuclei forming faint dark lines at regular intervals. In one specimen 4.8mm. in length five of these could be made out by close scrutiny, the second last of which was 0.37mm. in length by 0.20 in diameter, the last one being slightly larger and rounded posteriorly. These primary segments elongate with the growth of the strobila while the constrictions between them gradually deepen as their anterior and posterior ends enlarge slightly, the former relatively faster than the latter. When a total length of strobila of about 10mm. is reached the hindermost segment, itself now about 1.5mm. in length, begins to show faint transverse lines in its anterior end, decreasing in intensity from ahead backwards. These are the earliest traces of the divisions of the primary segments into the

secondary segments or definitive joints of the anterior ends of the adult strobilas. In other words the original or primary larva, plerocercoid or strobila divides up into secondary strobilas which eventually separate from each other and grow into the adult chains as described for the species. But long before separation takes place the entire development of the anterior segments with their characteristic posterior auricular appendages and the formation in particular of the first segment can be followed with a considerable degree of satisfaction in these primary strobilas (Fig. 12). Whereas the writer originally (1914b : 82, figs. 5 and 6, Pl. V) drew attention to young scolices with only 5 to 8 segments, he found in connection with the present study that the latter number, about 8 in external view or 16 or 17 in cleared specimens, is that developed by the secondary strobilas before detachment from the original chain. The smaller strobilas are now looked upon as having been prematurely and accidentally separated from the posterior end of the original or primary strobila. The attachment soon becomes very slight owing to the rapid deepening of the construction ahead of the first segment, and some time before the auricular appendages of the latter are fully delimited posteriorly, very little manipulation of even alcoholic specimens, let alone cleaned ones, suffices to break up the chain. The writer, however, succeeded in finding in the material at hand one primary strobila, 88mm. in length, showing twenty secondary strobilas including the undifferentiated anterior segments from which they are developed. Furthremore, the last two of these, 10.4 and 11.5mm. in length, showed in their posterior unsegmented portions the earliest traces of the rudiments of the reproductive organs. As has been already

intimated, the anterior segments form within the secondary or definitive strobilas by a gradual demarcation from ahead backwards, first internally in the parenchyma, actually as transverse layers of nuclei (Fig. 12) which will eventually form the posterior auriculate appendages, and then externally as shown in the figure.

A continued search for evidence in connection with the question of whether or not there is a definite number of segments, external and genital combined, brought out further interesting facts. The number was counted in several young strobilas evidently not long separated from the primary strobila with the following results in the case of four typical specimens: (1) Length, 19mm., number of segments, 45; (2) 27mm., 29 or 30; (3) 36.5mm., 30 (the posterior ones here ripe as in the next specimen); (4) 41mm., 32 segments. It would seem from these data that there is a more or less definite number of segments, which might be considered to be about 30. But in No. 3, segments 9, 10, and 11 were much elongated and show the earliest traces of further subdivision; while in No. 4 segments 10, 11 and 12 are likewise elongated and show not only similar traces of subdivision but particularly in the 11th early stages in the same formation of secondary strobilas as described above for the primary strobila in its posterior end! Similar elongated segments in other strobilas show this condition near their middles instead of posteriorly; so that here we have a tertiary subdivision which must be considered as by no means as regular as the secondary subdivision of the original primary segments. These facts explain, then, the aberrant nature of the strobila in this region, noted formerly by the writer

(vide supra), and the presence in material of chains showing anteriorly very young segments similar to those formed in the oldest attached secondary strobilas but posteriorly much older segments with well developed auricles and farther back the typical mature proglottides of the ordinary strobila. Consequently we must consider that there is not a definite number of segments formed but that further, irregular and evidently indefinite subdivision, resulting in the formation of an inconstant number, takes place chiefly in the middle portion of the anterior segmented region of what now must be called the secondary strobila.

As to where all of this development takes place the writer has not come to any definite conclusions, knowing as yet practically nothing of the life-history of the species, for, altho all stages may be found in the intestines of Amia calva, some of it may take place in the intermediate host. In a few cases primary strobilas showing three or more well developed secondary strobilas were found tightly coiled and surrounded by material which may have been from the intermediate host, whatever that is. At any rate it was of too firm a consistency to be merely coagulated mucous from the host's intestine.

On therother hand, this method of segmentation will now explain some facts in connection with the nervous andeexcretory systems that were previously considered very unique, to say the least.

In primary strobilas, even the youngest (Fig. 10) the excretory system consists, as in the adult, of a larger median vessel and two lateral vessels which run backward and unite in

the posterior end to form a plexus from which very many small vessels pass to the exterior by prominent foramina secondaria piercing the cuticula, much as described by Fraipont (1881 : 11, Fig. 7, Pl. II) for Bothriocephalus scorpii. In the youngest larva, that shown in Fig. 10, only the median vessel, which becomes greatly reduced in diameter about twice the length of the bulbs from the anterior end, is present in the scolex. It forms a simple plexus among the bulbs anteriorly. In primary strobilas, however, in which segmentation has gotten well under way, all three vessels are quite prominent even in good toto preparations, and pass close to each other as well as to the chief nerve strands, through the constrictions between the developing secondary strobilas, where the median vessel is somewhat enlarged. As they near the anterior end of the worm they give off numerous branches of their own calibre, and when they meet the large ganglionic masses, described below, diverge as four vessels (two on each side) and continue lateral to the bulbs to the tip of the scolex. Here, after forming an open plexus among the anterior ends of the former, they unite in a single median frontal loop. As the constrictions between the secondary strobilas deepen all three vessels likewise become gradually constricted until eventually they are cut off, and the adult conditions are subsequently developed by a process of turning in of both severed ends. And since the median vessel was considerably enlarged at the region of constriction, it remains thus in the hinder end of the adult strobila, as well as in the first segment (former scolex) as described and figured elsewhere by the writer (1914b : 93-95, Figs. 12, 37), while in the latter

it is joined by the lateral vessels to form the characteristic terminal vesicle.

The nervous system of the primary strobila consists of the two chief nerve strands passing thruout the segments, a quite irregular commissure connecting them anteriorly, and a very large ganglionic mass, situated some distance posterior to the proboscis bulbs. The chief nerve strands, which the quite indistinct at different levels but constantly located in the median frontal plane, diverge as they meet the ganglionic mass in passing forward, and consequently opposite the bulbs come to lie close to the subcuticula laterally (Fig. 15). About 0.2mm. from the tip of the scolex they are united by a very irregular but comparatively large transverse commissure, from which large trunks pass to the neighboring bulbs both forward and backward. This commissure was found to be present wholly or in part in about 12 sections of an 8μ transverse series, hence its length or longitudinal diameter is about 0.10mm., while its maximum depth between the lateral pairs of proboscides is about 40μ. Large branches are given off anteriad to the lateral walls of the bulbs and caudad to the central walls. In the latter case a large branch was found to leave the median portion of the commissure, which is incidentally freely pierced with excretory vessels, on each surface and shortly divides into two, each supplying the central walls of one of the frontal pairs of bulbs dorsally or ventrally (Fig. 15). The anterior branches likewise arise in a common trunk on each side, which is in reality the continuation of the lateral ganglionic enlargements of the commissure, but they supply the outside wall of the lateral pairs of

of bulbs. Imbedded in the commissure were seen numerous nuclei which, on account of their larger size than the neighboring parenchymatous nuclei, were interpreted as ganglionic or nervous in their nature. Numerous among the posterior ends of the bulbs and extending far from 0.8 to 0.9mm. backward beyond them (Fig. 11) there is present a large mass of large nucleated cells which in transverse sections (Fig. 16) are seen to occupy the whole of the medulla (and about the whole of the section) excepting for the excretory vessels. These cells are roughly spherical in shape and have a maximum diameter of 25μ, their nuclei being 5μ. On account of their finely granular consistency and their taking the orange-G counterstain quite as does the anterior nerve commissure they were interpreted as being ganglionic cells. And this view was supported on closer study by the discovery that they are not only united laterally with the chief nerve strands (Fig. 16), which can scarcely be distinguished from them at various levels, but with each other thru a complicated plexus of fine longitudinal strands which pass forward towards the bulbs and form around their bases an almost solid mass of fibrils (Fig. 11). From this mass large strands from 10 to 15μ in diameter pass into the bases of the bulbs, one for each, and are distributed among the retractor muscles of the proboscis which they evidently supply. In the youngest primary strobilas, but not in the older ones, this mass of fibrils at the bases of the bulbs evidently connects forwards by a few strands with the commissure.

Just as the definitive form of the anterior and posterior ends of the excretory system is explained by the separation of the

secondary strobilae and the subsequent healing over of the cut ends, so is that of the nervous system, particularly anteriorly. In the original description the writer (1914b : 93) said that: "The nervous system consists of a nerve-ring situated immediately beneath the tip of the scolex and covering the median excretory vesicle like a cap, and the two chief nerve strands passing back from it through the whole of the strobila. The former is a comparatively weakly developed structure (Fig. 11), elliptical in transverse section, with diameters of 60 and 40 μ." As was shown in Fig. 11, the nerve-ring is drawn out forward into a point which is directly opposite a small conical pit in the tip of the "scolex", facts which formerly seemed rather strange to the writer in comparison with conditions in other bothriocephalids. Now they, as well as the relatively small size of the nerve-ring, are explained by the contraction of the free end of the "scolex" after separation and the growing together of the ends of the nerve strands with subsequent differentiation into the nerve-ring. The close association of the nerve-ring and the terminal excretory vesicle is also quite comprehensible in the light of this method of development, for, since the nerve strands are situated close outside the lateral excretory vessels at the constrictions, they simply turn in towards the median line and unite immediately ahead of the junction of the latter with the median vessel.

As will be gathered from the foregoing description there is a most remarkable resemblance between the scolex of H. globuliforme and that of the Trypanorhyncha not only in the structure of the proboscides but also in the presence of the large mass of

ganglion cells associated with them posteriorly. Each proboscis consists of three parts: (1) a hollow tentacle, capable of evagination, (2) a short, permanently protruded stump, armed with thickly set minute cuticular spines, and (3) a comparatively elongated bulb; of which (1) and (2) may be compared respectively with the proboscis and the bulb of Tetrarhynchus or Rhynchobothrius. The proboscis, altho not provided with any kind of armature, is nevertheless supplied with a group of well developed retractor muscles which is evidently analogous in function to the single retractor muscle of the Trypanorhyncha. The bulb is not only provided with a musculature arranged so as to diminish on contraction the volume of the organ but is also lined with an epithelium like layer comparable to that of the members of the latter group. But since the bulb extends to the point of exit of the proboscis, there is no part strictly analogous to the proboscis -- sheath of Tetrarhynchus, altho the stump would at first sight seem to be such. Furthermore, the cells forming the large mass behind the bulbs in Haplobothrium, which are here interpreted as ganglionic cells, bear not a little resemblance to those described by Braun (1896 : 1294) after Pintner (1880), Lang (1881) and Niemiec (1888) as associated with the bulbs of Tetrarhynchus longicollis (v. Ben) (= Dibothriorhynchus ruficollis Monticelli) and considered by some to be ganglion cells and by others myoblasts. The distribution of the large nerve trunks arising from the nerve commissure is also somewhat suggestive of conditions in a few of the tetrarhynchids (cf. Braun) 1896 : 1293-94).

While the writer is not prepared to go further into this

comparison he would like to emphasize the significance of the layers composing the walls of the bulbs in H. globuliforme in connection with the possible origin of these most aberrant structures. In discussing the homologies of the proboscides of the Trypanorhyncha Benham in Lankester's "Treatise on Zoology" (p. 127) said that, "It appears more probable (Pintner) that each proboscis has been developed by the deepening and modification of an 'accessory sucker' of some Tetraphyllidean, as its relation to the bothridia, and its mode of development, closely agree with these structures. Functionally, too, it is a perfection of the armature plus the accessory sucker of three forms [Acanthocephala, Nemertini and Taenioids]; whilst there is no doubt that the 'phyllidea' of the two orders are identical." The fact that here the walls of the bulb, since they are composed of an outer layer of longitudinal muscles, a middle layer of circular fibres and an inner cuticular layer, are not only quite comparable but directly continuous with the cuticula and cuticular muscles of the body wall and in the reverse order, would seem to lend support to Pintner's view. For simple invagination of the external layers of the body wall in development would account for these structures, while the proboscis with its retractor muscles might well be formed by the modification of the external layers of an "accessory sucker". The writer has, however, no facts to support this theory since in the earliest primary strobilas or plerocercoids met with the proboscides were already well developed.

Subfamily 3. CYATHOCEPHALINAE Luehe, 1899, e.p.

Scolex unarmed, not longer than broad, with two surficial sucking grooves, more or less fused with one another or one terminal one of a sucker-like structure. External segmentation little expressed or quite absent. Genital organs in each segment simple. Genital openings surficial median. Vagina and uterus open into a common vestibule, -- in young proglottides near one another, -- lying behind the male opening and similar to the genital atrium of other cestodes, which may be surrounded by a sphincter like musculature. The genital openings of the different segments do not open on the same surface of the worm, but alternate irregularly, being sometimes on the one surface and sometimes on the other. Uterus a coiled canal without uterus-sac.

Sexually mature in the intestines of fishes.

Type genus: Cyathocephalus Kessler

The above is Luehe's (1910 : 23) diagnosis modified to read "may be surrounded, etc." instead of "is surrounded, etc." in connection with the genital sphincter, since in the species described below no such structure was found.

Genus 1. Cyathocephalus Kessler, 1868.

Taenia (part)	Pallas	1781 : 40.
Taenia (part.)	Botsch	1786 : 71,107.
Echinorhychus (part.)	Zeder	1803 : 291.
Cephalocotyleum	Diesing	1850 : 617.
Cyathocephalus	Kessler	1868 : 135

Cyathocephalus	Grimm	1871 : 502.
Monobothrium	"	" : 504.
Acrobothrium	Olsson	1872 : 40
Cyathocephalus	Zschokke	1884 : 37
"	Loennberg	1889 : 42
"	Kraemer	1892 : 648
"	Olsson	1893 : 14
"	Luehe	1899 : 53
"	Braun	1900a : 1697
"	Luehe	1900 : 12
"	Luehe	1910 : 22

Generic diagnosis: Scolex a single, undivided terminal sucking organ, which in its form and structure no longer shows an origin from two fused surficial bothria. External segmentation only slightly indicated. Sphincter surrounding the female genital cloaca apparently little developed.

Occurrence: In Teleosts.

Type species: Cyathocephalus truncatus (Pallas, 1781)

Cyathocephalus americanus sp.nov.

? 1897 Cyathocephalus truncatus Linton, 1897 : 428-29.

Specific diagnosis: With the characters of the genus. Small cestodes, up to a length of at least 11mm. with a maximum breadth of 1.1mm. Scolex funnel-shaped, 0.3-0.5mm. long and 0.5-0.7 broad, with revolute edges. Neck 1.0-1.8mm. in length. Segments twice as broad as long, terminal one rounded.

Cuticula 5μ in thickness, with no hooks nor spines; subcuticula 25 to 40μ .

10 to 13 sets of genitalia, beginning 1.5 to 2.0mm. from the anterior end. Strong tendency for the reproductive apertures to lie all on one surface of the strobila. Vagina opens behind uterus. Neither papillae nor sphincters around the genital openings.

Testes in two laterial fields in the medulla of the anterior portion of the proglottis, 60μ in diameter. Coiled vas deferens anterodorsal to cirrus-sac; no seminal vesicle before entering cirrus-sac nor connective tissue sack surrounding the whole duct. Protruded cirrus 0.2mm. in length by 0.12 in diameter at base. Cirrus-sac ovoid in shape 0.20-0.23mm. in length by 0.17 in diameter; no retractors connecting it with the dorsal body wall; large mass of glandular pigmented cells surrounding it dorsally and laterally.

Vagina 15μ in diameter; no sheath near its opening; receptaculum seminis 75μ . Spermiduct very short and narrow, 25 and 8 μ respectively. Ovary tubulolobular, fan-shaped; wings extending dorsally and laterally around the ventral genital ducts; isthmus prominent, 0.18 x 0.10mm.; ova in same 13-15μ in diameter. Oocapt 25μ in diameter. Vitelline follicles continuous from proglottis to proglottis, forming a layer 70μ thick in the cortical parenchyma, 20 to 35 μ in transections. Shell-gland dorsal, voluminous. No muscular sack surrounding the uterine rosette.

Eggs, 40 x 30μ .

Habitat: In stomach, pyloric coeca and intestine of the host.

Host	Locality	Collector	Authority
Coregonus clupeiformis	Outer Id., L.Superior	J. W. Milner	Linton, 1897b : 429.
" "	Off Giant's Tomb Id., Georgian Bay	Cooper	Cooper, (the present paper)

Type specimen : No. 165A, C. A. R. C.

Co-type : No. 165B, C. U. Ill.

Type locality : Georgian Bay, Lake Huron, off Giant's Tomb Island.

Altho the species described here is closely related to *C. truncatus* of Europe and evidently the same form was reported as such by Linton (1897 : 428) from the same host in which it was found by the writer, it presents so many differences, even barring some probable errors by Kraemer (1892), from that species that it is here considered to be new.

As shown in the appended table where the largest specimens at hand are dealt with, this species is considerably smaller than the Ruropean species which ranges from 6 to 40mm. in length by 1.5-4 in width. Linton gave these measurements as 7 and 1.2mm.

The general shape of the body, however, is the same as are the proportions of the scolex and proglottides. The border of the infundilobiform scolex (Fig. 18) is thickened and almost constantly rolled backward somewhat as in the figures given by Zschokke (1884a, Fig. 9) and Kraemer (1892, Fig. 5), the funnel being about 0.22mm. in depth and usually filled with a plug of mucous membrane from the host's alimentary tract. The posterior limits of the scolex are difficult to define since the organ gradually narrows

down and then as gradually enlarges again to form the neck. The latter was considered to include that portion of the anterior end of the worm between the narrowest region behind the scolex and the first vitelline follicles which are situated some distance ahead of the first cirrus-sac. The maximum breadth of the strobila is at the posterior end of either the first third or one half. The segments are, as described by various writers for C. truncatus, about twice as broad as long, the last one, however, being rounded posteriorly and provided with a notch in the middle which accommodates the exit of the excretory vesicle. They are, furthermore, closely united, as pointed out by Linton (1897 : 429) when he said that, "The bodies of these specimens appear to be unsegmented, or, at least, with only very faint indication of division into segments." As a matter of fact numerous transverse wrinkles present in most specimens make it almost impossible without the external evidences of the inner genitalia to distinguish the limits of the proglottides. And in this respect they agree with C. truncatus, since Zschokke (1884 : 38) said concerning the segments: "Ils sont solidement fixés les uns aux autres, leurs limites sont difficilement visibles." The following table gives the measurements of four of the largest specimens:

Number	165.4	165.5	43.1	165.1
Length	10mm.	9mm.	11mm.	7.5mm.
Maximum breadth	1.01	0.92	1.11	1.05
Length of neck	1.48	1.00	1.48	1.8
Breadth scolex, tip	0.55	0.53	0.74	0.64
" " , base	0.37	0.42	0.55	0.30
Length of scolex	0.42	0.33	0.61	0.50
Number of seta genitalia	13	12	13	10
First cirrus from ant. end	1.85	1.66	2.25	2.01
Remarks	Toto	Toto	Toto	Sectioned

The cuticula is 5μ in thickness over the scolex as well as on the segments and divided into two layers, the outer of which is about one-half as thick as the inner and more or less irregular in structure. In most places, in fact, it was found partially or wholly separated from the inner and more homogeneous layer and in such a manner as to present a distinctly wavy appearance. However, no such chitinous hooks as described by Kraemer (1892 : 10) for the cuticula of the lateral borders were seen, but the whole tissue is freely pierced with numerous foramina secundaria of the excretory system which in C. truncatus Kraemer considered to be the points of entrance of nutriment. The thickness of the cuticula, according to the same author, is 19μ , an outer irregular layer being 5μ and showing a sort of ecdysis ("Hautungsprocess"). This, however, may be simply the separation of the outer layer of the cuticula from the inner as mentioned here, since he said "Diese Auffassung wird dadurch erhärtet, dass sich an einigen Stellen

dieser Belag nicht findet, dafür eine junge homogene Cuticula," the latter being then the inner homogeneous layer. At any rate it is quite evident that the cuticula of C. truncatus is a much thicker tissue than that of the form described here, -- and no one else than Kraemer seems to have described it.

The subcuticula varies in thickness from 25 to 40 μ, being thus quite comparable to that of C. truncatus in which it is 38 μ. The elongated, quite columnar cells of the same were found to be 5 μ in diameter, as were their comparatively large nuclei, the respective measurements by Kraemer being 19 and 6 μ.

On account of the fact that the material studied was not as well fixed as the writer would like to have had it, the parenchyma and likewise the calcareous bodies were quite unsatisfactory from an anatomical standpoint. The spaces which were considered to have accommodated the latter, before they were dissolved out during fixation, -- and in some of them the nuclei of the bodies were still visible, -- were in general ellipsoidal to almost a spherical in shape and from 13 to 25 μ in length by 7-18 in width. According to Linton they are 10-20 μ long, while Zschokke gave them as from 8-10 μ, and Kraemer, 30 x 18 μ.

In general the musculature is as described by Kraemer, but all the groups are comparatively weakly developed (Fig. 19), the longitudinal layer, for instance, being only 20 μ in thickness in the median line posteriorly and about 60 μ in the neck region (76 μ in C. truncatus) where the dorsoventral and transverse fibres are also much stronger than elsewhere. In the anterior part of the neck, particularly immediately behind the scolex, the fibres

of the two latter series are much stronger, altho less numerous than farther back. As they pass the posterior end of the funnel they become circularly disposed, longitudinally as well as transversely, and from there on to the tip of the scolex gradually more numerous close around the funnel of the organ, for the control of which they obviously act as constrictors. Antagonizing these are numerous weaker radial fibres, arranged as in C. catenatus Riggenbach (= Diplocotyle Rudolphii Mont. -- Luehe 1902a : 320) where they were considered (Riggenbach, 1898 : 639) to be derived from the longitudinal muscles with which they are continuous at the base of the scolex. Altho they mingle freely, yet quite separately, among the latter, the writer is inclined to the same view regarding their homologies in C. americanus, since it is quite evident that the dorsoventral and transverse fibres, which might otherwise be considered to give rise to them become modified to form the circular muscles of the scolex. And this view is further supported by the fact that only a very few of the longitudinal muscles of the neck pass for a short distance beyond the bottom of the funnel, but most of them are inserted in the latter, thus functioning with the radial fibres in enlarging the organ of adhesion. As pointed out by Riggenbach these radial muscles are apparently absent from C. truncatus ; they were not described by Kraemer, but the enlargement of the funnel was considered to be accomplished by the contraction of the dorsoventral fibres (cf. his Fig. 1). The outermost layer of circular and longitudinal muscles in the scolex, which are merely extensions of the cuticular muscles of the neck region, are not nearly so strongly developed here as in

C. truncatus, so far as the writer can gather from a comparison of the material studied with Kraemer's description. There is, however, in the neck region, particularly in its anterior portion, a series of outer longitudinal muscles which, while situated in transections among the outer clear ends of the subcuticular cells and very close to the longitudinal cuticular fibres, are nevertheless quite distinct from the latter. At the base of the scolex they pass inwardly between the cells of the subcuticula and continue farther towards the anterior border of the funnel than do the inner longitudinal fibres. Posteriorly they diminish considerably in number but may readily be seen in the mature proglottides.

The nervous system is arranged in general as in C. truncatus, but the longitudinal trunks are only 36 μ thick by 13 wide (0.345mm. according to Kraemer). They are scarcely enlarged anteriorly to form ganglia, as shown in Kraemer's Fig. 5, but are each divided into two distinct dorsoventral halves which gradually diverge as they pass on into the walls of the funnel to form four large nerves. No single transverse commissure connecting the main trunks behind the cavity of the scolex was seen but rather a number of fine cross-connections which were not made out satisfactorily.

On account of the poor preservation of the parenchymatous ground tissue of the material studied the excretory system was not brought out in sections to the writer's satisfaction. All that can be said in this connection is that there is an inconstant number of longitudinal vessels in transection, evidently more than the six of C. truncatus, which do not occupy definite positions but anastomose freely with each other especially in the lateral portions of

the medulla. In the scolex these vessels are smaller and the anastomoses are much more numerous, while posteriorly at least two pass into a quite irregularly shaped terminal vesicle, which howefer in the light of Wolf's (1906) finds cannot be considered to be a true terminal excretory vesicle. As above stated, formmina secundaria are quite numerous in the cuticula.

The reproductive organs appear quite close behind the neck, the vitelline follicles being situated from 1.3 to 2.3mm. from the anterior border of the scolex, and the first cirrus-sacs from 1.6 to 2.2mm. From 10 to 13 sets of genitalia were observed foo this species. These follow each other closely and are not separated by any septa or other boundaries, the vitelline follicles being, in fact, strictly continuous from proglottis to proglottis. The openings of the cirrus-sacs vary from 0.45 to 0.75mm. apart, but, as pointed out by Kraemer, these measurements are of little diagnostic value on account of the different states of contraction. As in C. truncatus the reproductive openings are all on one surface of the proglottis but alternate as a unit inregularly from one surface to the other, there being, however, a strong tendency for them to lie all on the one face of the strobila. This alternation also involves the ovary, the isthmus of which is arbitrarily considered to be ventral. It usually lies on the same surface as the reproductive openings, so that when the latter passes to the opposite surface it moves accordingly. This alternation of the openings has, of course, been known ever since Pallas described Taenia truncata in 1781, but, so far as the writer is aware, no one has dealt with the relations between the openings and the ovary noted

here. Concerning this matter Kraemer said only: "Das Verhalten, dass die Geschlechtsorgane alternirend dorsal-und ventral nach aussen münden, erinnert in gewisser Beziehung an die alternierende marginalen Geschlechtsöffnungen verschiedener Fisch- und Vogel taenien, und wurde bereits von der ersten Beobachten, Pallas und Batsch erkannt, d.h., sie hatten auf beiden Flächen die fortlaufende Reihe der 'Punkte' wahrgenommen, ohne sie indessen als Ausmündungen der Sexualorgane zu deuten. Die neueren Beobachter haben sämmtlich dieses oben beschriebene Verhalten übersehen, und geben die Geschlechtsöffnungen als ventral gelegen an." But it should be mentioned here that whatever is the stimulus which, during the very early stages of development of the sets of genitalia from their nucleus rudiments, causes the reversal of the whole proglottis it would seem to be such at times as to fail to bring about the turning over of all parts of the rudiment. As shown in Fig. 20, which is a diagram of a sagittal series of seven proglottides including the end one, the cirrus and female genital cloaca of No. 3 from the top have gone to the opposite surface while the ovarian isthmus, represented by the solid black disc in each segment, has remained on the same surface as those in segments 1, 2 and 4 in the immediate neighborhood. Here the stimulus which brought about the unisurficiality of the latter may have influenced the ovarian portion of the common rudiment of No. 3 and caused it to lag behind, while the more peripheral rudiments of the cirrus, vagina and distal portions of the uterus were freer to move. This arrangement of the parts in the aberrant segment in question naturally caused considerable departures in the courses of the reproductive ducts from

the normal, as were observed.

The genital openings were found to vary from 75 to 115μ apart, but, as pointed out by Kraemer, these data are of very little specific value. The vagina and uterus open in a common genital sinus or cloaca, but unlike conditions in the European species the vagina opens constantly behind the uterus and slightly to one side and not ahead of it. Furthermore, neither papillae nor sphincter muscles were found around either or both genital openings in this species. The female genital cloaca, usually situated at the bottom of a depression and often on a low papilla, ranges from 30 to 60μ in depth. In frontal sections it is seen to be in the form of a transverse slit about 60μ in length, into the ends of which the vagina and uterus empty; that is, the vagina opens diagonally behind the uterus and usually to the right of it. It is lined by a direct continuation of the cuticula from the surface of the segment. The general habit of the reproductive organs is shown in Fig. 31 of a frontal section of a mature proglottis.

The testes are situated in the medullary parenchyma in two fields lateral to the cirrus-sac, or more strictly speaking, in the lateral portions of the region between the cirrus-sac and the ovary of the proglottis ahead, since they extend forward to the latter and backward to the anterior ends of the wings of the ovary of the segment to which they belong. They are noteworthy on account of their clear appearance (Fig. 19), as in <u>C. truncatus</u>, very little contents having been seen in all of the sections made. While their shape is usually spherical or somewhat flattened enteroposteriorly according to the condition of contraction of the segment, their

maximum diameter was found to be about 60 μ. The coils of the vas deferens, altogether about 0.30mm. in diameter are accommodated in the somewhat confined space dorsal and anterior to the cirrus-sac, extending to the ovary ahead (Fig. 21). Whereas Kraemer gave the diameter of the duct as 0.133mm. or about eight times as much as just before it enters the cirrus-sac, it was found to be only 44μ at the most in this species. Furthermore, it was not found to be enlarged to form a seminal vesicle close to the cirrus-sac, as shown in Kraemer's Fig. 6 and 13, but to gradually diminish in size until as it pierces the wall of the latter its diameter is only 10μ. Nor is the whole vas deferens enclosed in a connective tissue sack, such as described by Kraemer. Within the pouch it enlarges considerably to form a thin-walled inner seminal vesicles which is quite conspicuous in sections, situated for the most part nearer the proximal end of the former but often lying alongside the cirrus proper. It may attain a diameter of 50μ even when empty, -- in none of the sections made was it found to contain spermatozoa, these having been probably extruded at the moment of fixation. Then follows the cirrus proper which is sharply separated from the seminal vesicle, since it protrudes backward into the latter with a diameter of 10 μ and for a distance of from 15 to 35μ. The cirri were found protruded in most of the specimens at hand, in which case they had a maximum length of 200μ, diameter at the base, 120μ, and at the tip about 40μ. The thick cuticula covering the organ is decidedly roughened or irregularly "cleft", especially towards the tip, but not provided with spines of any kind. Incidentally, sections show that the protrusion of the cirrus, on

account of its size, results in the eversion of almost the whole of the contents of the sac. The length of the cirrus within the sac is at least 185μ, -- it is usually bent once in its proximal portion, -- while its diameter varies considerably. The layer of parenchymatous and myoblastic nuclei surrounding the cirrus within the sack is about 10μ in thickness as compared with 5μ in C. truncatus. In sections of the extended cirrus most of these nuclei appear in the tip of the organ surrounding a good deal of the cuticula which still remains invaginated; but they are in all probability myoblastic as are others farther back along the course of the retractor fibres. In frontal sections the cirrus-sac is circular in outline (Fig. 21) with a maximum diameter of 175μ, while in transverse and longitudinal sections the depth ranges from 200 to 230μ, the whole structure being somewhat ovoid in shape with its slightly smaller end directed outwardly. Its wall is comparatively thin, ill defined and composed of a somewhat loose network of muscular fibres running irregularly obliguely in all directions, so that sections cut in any plane show them almost circularly arranged. With emission of the cirrus the wall is fairly difficult to locate, since its innermost fibres are not easily differentiated from the retractors of the cirrus proper which bulk largely in the contents of the sac and since it is not provided with any dorsal trtractors connecting it with the dorsal body wall as described by Kraemer for C. truncatus. Forming a sort of gland closely applied to the wall of that part of the cirrus-sac within the medulla there is to be seen, even in toto preparations, a comparatively large mass of large darkly pigmented

polygonal cells (Fig. 21). In frontal sections they lie on each side of the sac, not extending much beyond its anterior and posterior edges, the whole structure being thus shaped somewhat like a saddle. Each cell is elongate in shape, provided with a well defined wall, prominent tho not especially large nucleus, and very granular and highly pigmented cytoplasm, the color of the pigment being dark brown. Altho they are very closely arranged around the wall of the cirrus-pouch and most of them are quite pointed towards the same, their function is pretty much a matter of conjecture, unless perhaps they are the much modified myoblasts of the muscles of the walls of the pouch, which is suggested by the relations of the inner attenuated ends of some of them with the latter. No such cells have been described for the European species, so far as the writer is aware; but here it must be emphasized that they are very conspicuous.

From its opening which has been dealt with above the vagina proceeds dorsally almost at right angles to the surface of the proglottis, and then within the medulla turns backward with a few coils to expand into a comparatively enormous receptaculum seminis which on account of its size, can scarcely be distinguished from one of the coils of the uterus unless it is traced out. At the turn in its course it has a diameter of about 15 μ and is lined with a continuation of the cuticula of the female genital cloaca, 5 μ in thickness and surrounded by a layer of circular muscles. As it passes above the ovarian isthmus its cuticular lining gradually diminishes in thickness so that the seminal receptacle is provided with a very thin layer only. While the latter may have a diameter of 75 μ slightly behind the isthmus of the ovary, it

narrows down very abruptly to a very small spermiduct, 8 μ in diameter and about 35 μ in length before joining the oviduct. In distinct contract with C. truncatus there is no "connective tissue and muscular sac" surrounding the beginning of the vagina as described by Kraemer, but only the usual mass of nucleu most of which are subcuticular in their nature. The ovary (Figs. 19, 21) is a tubulolobular organ, the limbs of which extend fanwise laterally and dorsally from the ventral isthmus anteriorly as far as the cirrus-sac and dorsally thruout the whole of the medulla, thus surrounding the central connections of the genital ducts and the coils of the uterus (Fig. 21). The wings in whose irregularly shaped tubules young ova in various stages of development are to be seen, connect with the rounded isthmus by narrow portions quite as described and figured by Kraemer, altho he evidently erroneously called the isthmus the "oo̊typ." The latter in C. americanus has a width of 0.18mm. by a length of 0.10 as compared with the similar measurements of 0.19 and 0.07mm. in the cases of C. truncatus. Ova from the isthmus measured from 13 to 15 μ in diameter, their nuclei 7-8 and their nucleioli 4, those of the latter species being 9-12 μ according to Grimm (1871) and 15 μ according to Kraemer who gave the diameter of their nuclei as 9 μ. The oviduct begins with a rather short oocapt (Fig. 23), 26 μ in diameter, and proceeds for only a comparatively short distance, with a diameter of from 15 to 20 μ, before being joined by the spermiduct. A little farther dorsally it is met by the vitelline duct which comes from the ventral portion of the medulla just ahead of the isthmus where it is formed by the union of a right and left duct as in

in _C. truncatus_. Thruout its dorsoventral course it is expanded with a vitelline reservoir which may reach a diameter of 40μ, especially ventrally. Immediately outside of the longitudinal muscles the vitelline follicles form a compact layer about 70μ in thickness (152 μ in _C. truncatus_), continuous from proglottis to proglottis and broken only immediately around the reproductive openings. In frontal sections where they are cut tranversely their greatest diameters being at right angles to the surface of the proglottis, they range from 30 to 85μ. since they are usually somewhat flattened anteroposteriorly. Their number in transverse sections baries from 20 to 35, 45 being given by Kraemer. From its point of origin to a short distance beyond the entrance of the vitelline duct, the ovident is lined with epithelial cells with prominent nuclei but indistinct boundaries, so that the whole is of the nature of a syncitium. But soon this epithelium becomes modified so that, as the duct continues with a few coils to the opposite side of the proglottis, its walls are quite thin yet clearly nucleate. Then as it further enlarges dorsally it becomes surrounded with the voluminous shell-gland which follows the tube thru a number of its coils (Figs. 19 and 21) even on to the beginning of the uterus, for in frontal sections about one half of the posterior half of the uterine rosette is surrounded by them (Fig. 31). The cells composing the gland are comparatively short, stout and well defined, their nuclei large with the nucleoplasm quite clear like the cytoplasm. No shell-gland such as described by Kraemer was found in this species. Beyond this elongated ootype the duct continues as the uterus proper which has its largest coils,

up to a diameter of 0.10mm. or more when filled with eggs (0.038mm. in *C. truncatus*), just behind the cirrus-sac. Before reaching the opening, the position of which has been stated above, the tube narrows down quickly. Thruout its course it is lined with a much attenuated epithelium, the nuclei of which, however, stand out prominently towards the lumen. In this species there is no muscular sack surrounding the uterus, as described and figured by Kraemer.

The largest eggs in the uterus not in a collapsed state, were found to be ellipsoidal in shape and 40 x 30 μ in size. Linton gave the size when preserved in acetic acid as 50 x 32μ ; while the measurements for *C. truncatus* have been given as 95 x 76 μ (Kraemer) and 44-51 x 33-36 μ (Luehe, 1910). Since most of the eggs seen in the uteri of the setions made were quite young, many of them not having gone thru the first cleavage as yet, the writer is of the opinion that the size of the egg of this species is probably the same as that given by Luehe for *C. truncatus* in Europe.

Altho, so far as the writer is aware no one has as yet studied the early stages in the development of *C. truncatus*, Wolf (1906) discovered that the intermediate host is *Gammarus pulex* and that the transfer to the final hosts is a direct one. As regards *C. americanus* the writer is unable to name the intermediate host, but he is of the opinion that further work will in all probability show that in *Pontoporeia hoyi* (Stimpson Mss.), at least in Georgian Bay where it is found in large numbers as practically the only food of *Coregonus clupeiformis* in which the parasite was found (vide Huntsman, 1915 : 150).

In the above description it has been shown that this species differs from the well known C. truncatus of Europe in a great many points, but in none so radically as the following: The absence of chitinous hooks on the cuticula of the lateral borders; the presence of radial muscles in the walls of the scolex and of a number of fine nerve commissures connecting the chief nerve strands anteriorly instead of a single one; the vagina opening behind the uterus opening; the absence of papillae and sphincter muscles surrounding the genital openings; no enlargement of the vas deferens to form a seminal vesicle just before entering the cirrus-pouch; no connective tissue sac surrounding the whole of the coiled vas deferens; the absence of dorsal retractor muscles of the cirrus-sac, and the presence of the peculiar glands closely surrounding the same; no "connective tissue and muscular sac" surrounding the beginning of the vagina; the very different central connections of the genital ducts as regards the ovarian isthmus ("ootyp" of Kraemer); and, lastly, the absence of any such "shell-gland" as described by the same author. Consequently the writer considers this the American form to be specifically different from the European form and proposes the name Cyathocephalus americanus sp.nov.

The material studied consisted of two lots, Nos. 43 and 165 of the writer's collection from the stomachs of several specimens of Coregonus Clupeiformis (Mitchell) from Georgian Bay, Lake Huron, as listed above.

Subfamily 4. MARSIPOMETRINAE subfam.nov.

Scolex with two typical and fairly deep bothria and a terminal disc. External segmentation very distinct and regular. Opening of cirrus and vagina marginal, irregularly alternating; uterus-opening surficial, ventral, on the same level with the genital cloaca or very slightly behind it. Only one set of genitalia in each proglottis. Testes in medulla between the nerve strands. Muscular vesicula seminalis outside of the cirrus-sac absent. Receptaculum seminis large, sharply separated from the sperm-duct. Ovary not exactly in the median line but slightly approaching the margin bearing the genital cloaca, ventral, as is the shell-gland. Uterus in the form of a sac developed by the enlargement inwardly of that portion of the duct passing thru the cortical parenchyma. Eggs without opercula.

Type genus : Marsipometra Cooper.

The above characterization of the subfamily is the result of a comparison of M. hastata with the existing subfamilies of the Diphyllobothriidae in none of which it could be located. As regards the general form of the scolex and the facts that the genital cloaca is marginal and that a vesicula seminalis is absent, it comes closest to the Triaenophorinae; otherwise, however, it is related to other subfamilies. External segmentation is distinct and very regular, a neck being present as in Diphyllobothrium and Bothridium of the Diphyllobothriinae. The uterus-opening is on the same level with the genital cloaca, and not ahead of it as in the Triaeno-

phorinae. As in most of the subfamilies there is only one set of genitalia in each proglottis. The testes are situated in the medulla between the nerve strands as in the Haplobothriinae. Unlike the structure in the Triaenophorinae, the receptaculum seminis is large and sharply separated from its continuation, the spermiduct, which also obtains for the Ligulinae, Haplobothriinae, Diphyllobothriinae and Cyathocephalus. The ovary is comparable to that of Triaenophorus, Anchistrocephalus and Anonchocephalus (cf. Luche, 1902a : 323) in that it is not exactly in the median line but towards the margin bearing the genital cloaca. As in the Triaenophorinae, however, the uterus "nie die sogenannte Rosettenform bildend, vor seiner Mündung meist etwas erweitert, ohne dass indessen diese Erweiterung verhältnissmässig so beträchtlich ist, wie die sogennnnte Uterushöhle der meisten Ptychobothriiden." This latter difference is further emphasized by the fact that at no stage in its development is the beginning of the uterus, which might be considered at first sight to be a true uterine duct, sharply separated from the enlarged portion as in the Ptychobothriidae, which has been discussed above. The outstanding feature that the eggs are nonoperculate has been noted under the remarks on the family.

Genus Marsipometra gen. nov.

Generic diagnosis: Scolex unarmed, sagittate. Neck present, strobila flat, ribbon-shaped; proglottides almost rectangular, posterior borders only slightly projecting. Nerve strands far towards the margins, dorsal to the cirrus-sac and vagina. Testes

in two lateral fields united ahead of and behind the uterus-sac and central genital ducts. Vas deferens much coiled proximally, only weakly so close to the cirrus-sac. Receptaculum seminis very long. Ovary reniform, wings tubulolobular, isthmus thick. Shell gland not in the middle of the genital complex but towards the cloaca, ahead of the ovary. Vitelline follicles numerous not in two lateral fields but continuous from side to side in the anterior and posterior regions of the proglottis, situated among the body muscles. Uterus-sac pouched, occupying the whole of the medulla dorsoventrally but not transversely. Uterus opening towards the margin bearing the genital cloaca. -- μαρσιππίον, a little pouch; μήτρα , the uterus.

Type species : *Marsipometra hastata* (Linton).

On account of the fact that there is only one species known, the above generic characters have been arrived at by the writer much as in the case of *Haplobothrium*, with, of course, strict attention in a comparative way to those of the genera of the Triaenophorinae. The writer would like to call attention at this point to the great similarity between *Marsipometra* and *Haplobothrium* in that each is found in an isolated genus of fishes, respectively *Polyodon* and *Amia* which in turn are relegated to isolated families and orders. As suggested previously by the writer (1914a : 4) in dealing with *Haplobothrium*, the unique and generalized nature of these two genera is doubtless due to the great age of their respective hosts. On account of the fact that it has a typical bothriocephalid scolex *Marsipometra* would seem to be the

younger of the two, for evidently a longer period of time must have been required for the development of the peculiar trypanorhynchous scolex and method of segmentation of Haplobothrium, if, indeed, both are not due to extreme degeneration, comparatively speaking.

Marsipometra hastata (Linton
(Figs. 23-30.)

1897 Dibothrium hastatum Linton 1897 : 431-33.

1900 Bothriotaenia hastata Ariola 1900 : 440.

Specific diagnosis: With the characters of the genus. Medium sized cestodes up to a length of 110mm. with a maximum breadth of 3mm. at the middle. Scolex with terminal disc, deep bothria and prominent posterior borders, 1.5-2.8mm. in length, 0.5-1.8mm. in width anteriorly and 1.8-2.0 posteriorly. Subcylindrical neck, 0.8-1.5mm. wide. First segments very short and wide, middle much broader than long and rectangular in outline, posterior ones quadrate to slightly larger than broad. Whole strobila much depressed.

Cuticula 5μ in thickness, subcuticula 40-50. Calcareous bodies 18 x 13μ. Longitudinal musculature weakly developed, that of scolex strong. Nerve strands 15 to 25μ in diameter. Four main excretory vessels in the strobila.

Genital cloaca 40-60μ in depth, at the middle of the margin of the proglottis; irregularly alternating; hermaphroditic duct present, also sphincter cloacae. Vagina opens immediately ahead of the cirrus.

Testes ellipsoidal, 60-90μ in diameter, 80 to 120 in

number, arranged in a single layer in the medulla and interrupted only centrally. Vas deferens a circular mass of coils, 0.25 to 0.30mm. in diameter dorsal to the uterus-sac, or to one side of it. Seminal vesicle within the cirrus-sac, 50 to 60 μ in diameter; cirrus proper slender, 0.20mm. in length, 3-15 μ in diameter. Cirrus-sac elongate, flask-shaped, 0.35mm. in length, 110 μ in maximum diameter.

Vagina 15 to 20 μ in diameter, passes to median line ventrally then dorsal to the uterus. Receptaculum seminis median, 90 μ in diameter. Ovary reniform tubulolobular, 0.45mm. wide and 0.18 long; isthmus thick, ventral. Oocapt 40 μ long and 18 in diameter. Two ventral vitelline ducts; common vitelline duct 20 μ in diameter. Vitelline follicles irregular in shape and size, among the transverse and longitudinal muscles, forming a continuous layer around the proglottis excepting for median circular areas dorsally and ventrally. Shell-gland small, compact, ventral, 115 x 55 μ. Uterine duct with only a few dorsoventral coils near the median line. Uterus-sac circular in outline, 1.0mm. in diameter, divided by deep incisions into 5 to 8 pouches, filling up the whole medulla dorsoventrally but not laterally; openings opposite the genital cloaca or slightly behind its level, in young segments towards the margin bearing the genital cloaca, in gravid ones almost in the median line.

Eggs, 45 x 36 μ, non-operculate.

Habitat: Intestine of host.

Host	Locality	Collector	Authority
Polyodon spathula (type host)	Ohio R., Washington, Pa.	E. Linton	Linton 1897 : 431.
" "	Ill.R., Beardstown, Ill.	H.J. Van-cleave	Cooper (the present paper)
" "	L. des Allemands, Georgia	H. B. Ward	"
" "	Miss. R., Keokuk, Iowa	"	"
" "	Miss. R., Fairport, Iowa	"	"

Type specimen : No. 4724, U.S.N.M. Coll.

Type locality : Ohio River, Washington, Pennsylvania.

This species was originally described by Linton but with so little attention to the internal anatomy that up to the present it has remained pretty much a species inquirenda et incerta sedis, as pointed out by Luehe (1899c : 40; 1900a : 106); altho Ariola (1900 : 440-441) placed it in the now obsolete genus Bothriotaenia Railliet.

Linton described the color of the living forms as " ... at first lemon-yellow; after lying in water for a few minutes the bodies become colorless or faintly bluish translucent, while the heads remained yellowish." Regarding their method of attachment he said: "Two pits were found excavated in the mucous and sub-mucous layers of the pylorus near the spinal valve, in which the heads of a number of Dibothria were inserted." The length of the worm was recorded by the same writer as from 35 to 78 mm. while the maximum breadth was 1.7mm. As shown in the table below the largest

examined by the writer was one 110mm. in length with a maximum breadth of 3mm., which, however, showed the characteristic opaque white uterus-sac filled with eggs in only the last eight proglottides. The scolex (Figs. 23, 24, 29 and 30) and strobila are, as described by Linton, " ... sagittate (when at rest and contracted), terminated anteriorly with a button shaped tip [the terminal disc] which is bluntly rounded in front and marked off from the remainder of the head by a slight constriction, in life angled posteriorly; pits [bothria] variable in life but usually elliptical, often with anterior margin acuminate and sometimes with posterior margin indistinct. The head is angled posteriorly both laterally [surficially] and marginally, presenting a quite characteristic appearance in the living worm. Neck subcylindrical, narrower than the head. The segments begin some distance (6 or 8mm.) back of the head, as faint transverse lines. The first distinct segments are closely crowded much broader than long, median segments squarish [but still much broader than long], posterior segments usually a little longer than broad, rectangular, apparently separating rather easily. ... Posterior angles of the segments slightly projecting. ... Outline of most of the strobilas nearly linear and about the same breadth as the head. All the segments were remarkably regular in outline, no irregularities being observed. While this regularity in the form of the proglottides and in their gradual increase in size anteriorly and change of shape posteriorly is especially noteworthy in this species, the writer met with a few cases of intercalated triangular and aberrantly subdivided segments in the material studied. It should be emphasized, too, that the

whole strobila including even the scolex is constantly much flattened dorsoventrally, which also assists in giving the worm a quite diagrammatic appearance; and as will be seen below this extends to the internal anatomy. The following table gives the measurements of four specimens, together with those by Linton for comparison:

	4724	4783	16.292.1	154	16.292.2	17.11
Length	60mm.	45mm.	76mm.	39mm.	61mm.	110mm.
Length of scolex	2.75	1.85	1.48	1.75	2.34	2.01
Width term. disc.	1.8	....	0.60	0.55	0.73	0.80
Depth " "	....	....	0.43	0.31	0.60	0.42
Width at base	2.0	1.7	1.35	1.31	1.83	1.95
Depth " "	....	1.3	1.16	0.96	0;98	1.10
Width of neck	1.1	....	0.87	0.88	1.40	1.52
Depth " "	....	0.4	0.36	0.37	0.48	0.68
Length middle segs.	....	0.35	0.75	0.46	0.80	0.73
Width of same	....	2.5	2.32	1.38	2.75	2.44
Length post. segs.	1.13	0.55	1.5	0.85	0.90	1.52
Width of same	2.0	2.7	1.4	1.10	2.85	2.44
Maximum breadth	....	....	2.38	1.38	3.0	3.0
Measured in	water	alcohol	O.W.	C.W.	Alc.	Formol.

The cuticula, 5 μ in thickness, consists of two layers of equal thickness, an outer irregular and more darkly staining layer, which is sloughed off in many places, and an inner, more homogeneous and lighter stratum between which the outermost portion of the inner layer shows as a dark bounding membrane. Altho only about one half

as thick on the outside of the scolex and still thinner on the inside of the bothria, it was not found to be modified into minute spines on the edges of the terminal disc nor hinder end of the scolex where they might be expected. Their absence also on the posterior borders of the proglottides (cf. Haplobothrium globuliforme) is not surprising since these protrude only very slightly. The subcuticula varies from 40 to 50 μ in thickness and is made up of narrow elongated cylindrical cells with small nuclei, the outer ends of which are dendritic and quite separate from each other as are the bodies themselves. The meshes of the parenchyma are very loose and open, the spaces being large and the strands of the cytoplasmic framework considerably narower than the small nuclei which are located as usual at the intersections but surrounded by only a limited amount of protoplasm. Linton stated that, "The segments contain numerous calcareous bodies, which exhibit a concentric structure." In the sections made the writer found them fairly plentiful in all parts of the medulla and cortex and even among the subcuticular cells, elliptical or oval in outline, the largest having dimensions of 18 x 13 μ.

The musculature of this species, excepting for that of the scolex which is well developed, is comparatively weak, no one series not even the longitudinal, being especially strong, altho all groups are prominent in that they consist of more or less isolated fibres quite diagrammatically arranged. Their conspicuousness is, in fact, amplified by the fine texture of the parenchyma. The frontal or transverse series do not form a compact layer closely applied to the inside of the longitudinal muscles but, as shown in

Fig. 25, a stratum of varying thickness; owing to the degree of separation of the fibres, especially laterally. The myoblastic nuclei of many of them can be easily seen. The sagittal series are, however, quite prominent, equally distributed from border to border of the strobila and show their myoblastic nuclei and surrounding cytoplasm very clearly, reminding one of the dorsoventral muscles of Abothrium rugosum (vide infra). While the fibres of both these series are only slightly more numerous opposite the posterior borders of the proglottides, where they form more or less distinct septa, they are very well developed in the neck and anterior segments. The longitudinal muscles form only a single layer of loosely arranged fascicles of irregular size in the middle and posterior segments, but in the neck they form a much thicker stratum, showing no distinct bundles and occupying the whole of the space between the transverse muscles and the subcuticular nuclei. Altho, as above mentioned, the posterior borders of the proglottides are not very prominent, there is a representative series of outer longitudinal muscles, best seen in the middle segments where they are situated close to the longitudinal cuticular fibres with which they are easily confused. Concerning the latter all that need be said is that they are well developed and consist of isolated fibres which render the two layers all the more visible.

The musculature of the scolex is, as might be judged from its size and its shape, very powerful. While the longitudinal muscles of the neck merely enter the base of the scolex, the transverse and sagittal fibres are directly continuous with the circular and radial fibres, respectively, of the latter. Here, however, the

radial fibres are quite separate from the dorsoventral fibres with which they are considered to be homologous, especially laterally where they pass from the cuticula lining the bothria to the sides of the scolex as in other bothriocephalids with prominent bothrial walls. Farther forwadd the sagittal muscles pooper passing between the bothria are scarce, their function being taken over by the very numerous and closely arranged radial fibres which are quite as plentiful in the median line as laterally. In the termina disc both transverse and dorsoventral fibres are again prominent, while the radial ones are absent. Posteriorly the latter pass down along the sharp edges of the beginning of the neck. Frontal sections demonstrate the presence in the edge of the terminal disc as well as in the posterior borders of the scolex of two series of longitudinal arcuate or radial fibres arranged for the control of these prominent ridges. These are perhaps modified portions of the outer longitudinal muscles which are very numerous in the scolex and converge in the anterior portions of the edges of the walls of the bothria to become attached to the edge of the terminal disc at the four respective points.

The chief nerve strands, from 15 to 25 μ in dorsoventral diameter and from 15 to 20 μ in lateral diameter, are situated far towards the edges of the medulla and in the median frontal plane or somewhat dorsally (Fig. 35). They pass dorsal to the junction between the lateral and middle thirds of the cirrus-sac and consequently dorsal to the vagina. In the neck they are located in the very borders of the medullary parenchyma, but as they pass into the base of the scolex they approach the median line somewhat. As

they pass on with a varying diameter towards the tip of the scolex, they givenoff a number of branches to the walls of the bothria and finally enlarge in the terminal disc to two ganglia, each with a diameter of about 50μ, which givenoff in turn numerous large branches to the immediate neighborhood. Each of these ganglia is divided into two large trunks which, however, continue only a very short distance farther forward before they are joined by two commissures.to their fellows of the opposite side of the scolex in such a way that the two branches of the ganglia on each surface of the sxolex are connected. In frontal sections each of these commissures is seen to be bowed slightly forward into the tip of the terminal disc and to give off further forward on each side a large branch which passes farther into the latter.

The excretory system consists of a varying number of vessels of which four pursue a more or less constant course thruout the medulla of the strobila. These are found at all levels in transections and are separated from each other in the transverse direction by different distances. The outermost two, however, are slightly larger and have thinner walls than the innermost pair. They give off numerous large branches and are connected by various anastomoses with each other and the more peripheral vessels. In the neck they cannot be followed as well, while close to the scolex they lose their identity and break up into a plexus of very small vessles which ramifies forward thruout the latter. In the posterior border of the scolex, however, a small branch on each side takes a straight course just within the nerve strand for a short distance. Flame-cells are quite numerous and readily discernible especially

in the medullary parenchyma. In young strobilas where no segments have yet been lost two comparatively large excretory vessels pass backward to the posterior end where they unite into a small narrow terminal vesicle. This in a larva 12.4mm. in length was 40μ long by 10μ wide while the diameter of the excretory vessels was 15μ.

The earliest traces of the reproductive organs in the form of a transverse line in either half of the proglottis (the rudiments of the vagina, cirrus-sac and lateral portions of the vas deferens) appear from 4 to 10mm. from the tip of the scolex, while the first eggs are seen in the uterus-sacs from 25 to 35mm. from the same point. The development of all of the genitalia is very gradual and can be easily followed in good toto preparations, since the diagrammatic nature of the worm, above mentioned, extends to the reproductive system, making this species an ideal one for study. The cirrus and vagina open into the common genital cloaca, which is situated in the middle of the margin of the proglottis, while the uterus opens on the ventral surface, not in the median line but towards the side occupied by the atrium. The cloacae alternate irregularly from side to side, from one to ten having been found occupying the same margin of successive proglottides. The following figures represent the number of such segments before the genital aperture changes to the other side in specimen No. 16.292.1 of the above table: 1, 2, 1, 8, 1, 1, 1, 2,2, 3, 3, 1, 2, 2, 10, 1, 1, 1, 3, 3, 2, 2, 1, 4, 1, 1, 2, 2, 5, 2, 2, 3, 6, 6, 1, 1, 1, 1, 1, 3, 2, 1, 3, 3,2 -- as far forward as the rudiments could be conveniently traced. The genital cloaca (Figs. 27 and 28)

is elliptical in outline when viewed from the side, its longer diameter being directed dorsoventrally, while in transverse sections it is squarish in outline. The dorsoventral diameter, longitudinal dimater and depth are, respectively, 70-85 μ, 40-55 μ and 40-60 μ. Into the middle of the bottom of this depression opens the hermaphroditic duct about 60 μ in length, into the bottom of which in turn opens the vagina immediately ahead of the cirrus. Since the cirrus proper is a long slender tube and since the external portion of the hermaphroditic duct is usually found quite tightly closed and the end of the cirrus turned around toward the opening of the vagina, self-impregnation would seem to be quite probable in this species. On the other hand the fact that the genital cloaca is so well formed and further that it is surrounded by a well developed sphincter and a series of muscular fibres radiating out into the surrounding parenchyma, as shown in Figs. 27 and 28, argue in favor of its use in cross-fertilization. No protruded cirri was seen, however, in the material at hand. Perhaps both methods of fertilization occur.

The testes are spherical to ellipsoidal in shape, their longest diameters being dorsoventral, while their cross-sections are usually circular in outline. In segments where there are as yet only a few eggs in the uteri their dorsoventral and transverse diameters are, respectively, 85-90 μ and 60-80 μ. In the anterior and posterior ends of the proglottis, -- they are not continuous from segment to segment but separated by the aggregations of sagittal and transverse muscles mentioned above as forming more or less complete septa, -- they form a single layer situated in the

medulla in the median frontal plane, but are widely separated in the middle of the proglottis by the central genital organs and ducts, especially the uterus-sac. Their number ranges from 80 to 120 for each proglottis. While the wall of the testis consists of a very thin membrane from which nuclei protrude inwardly, the contents are such as to show the process of spermato-genesis with comparatively great clearness. The vas deferens forms a circular mass of coils, 0.25 to 0.30mm. in diameter, applied like a cap to the dorsal side of the developing uterus-sac and thus close to the inner end of the cirrus-sac. When the uterus becomes gorged with eggs it is pushed aside somewhat but still retains similar relations with one of the pouches of the former, located in the direction of the genital cloaca (Fig. 36). In the mass of coils the duct is usually distended with spermatozoa to a diameter of 40μ. It gradually narrows down to a diameter of 15μ before entering the cirrus-sac before which there is, however, no seminal vesicle. But within the pouch the vas deferens enlarges to form a large seminal vesicle, which with a diameter of from 50 to 60μ takes only a few coils before passing on as the cirrus proper from which it is sharply separated (Fig. 38). The cirrus is a slender tube from 0.17 to 0.32mm. in length within the pouch and from 15μ in diameter nearest the seminal vesicle to 8μ at its opening. It is lined with a thin cuticula which is circularly cleft in its proximal one-third but almost smooth for the rest of its length, nowhere, however, showing anything in the nature of an armament. The cirrus-sac (Fig. 38) is an elongated flask-shaped structure with a maximum diameter proximally of 110μ and distally of 40μ and a length of

0.35mm. The neck of the organ usually shows a couple of dorso-ventral curves, while about 30μ of its distal end protrudes into the hermaphroditic duct. Its walls are comparatively thin and composed of an inner layer of circular muscles and an outer weaker and much less compact layer of longitudinal fibres. Apart from the seminal vesicle which occupies almost the whole of the proximal enlarged portion and the narrow cirrus the contents consist of only a limited amount of parenchymatous tissue and a very few feeble retractor muscles. The whole structure of the cirrus-sac is in fact such as to suggest that the function is that of an organ for the expulsion of spermatozoa rather than for the emission of a copulatory organ; altho a few muscles passing from the body wall around the cloaca to the anterior part of the neck of the sac (Figs. 27, 28) would seem to indicate that a small portion at least of the cirrus is protruded, perhaps during self-fertilization.

Altho the vagina opens into the hermaphroditic duct directly ahead of the cirrus, it almost immediately curves around the distal portion of the cirrus-sac to the anteroventral side of the latter which it follows closely towards the median line. Close to the wall of the inner end of the cirrus-sac, however, it crosses the distal coils of the vas deferens towards the dorsal surface and skirts the uterus-sac. When it reaches the median line above the sack it turns sharply downward and backward. The vagina has a diameter of from 15 to 20μ opposite the middle of the cirrus-sac and is lined with only a comparatively thin layer of cuticula. It very gradually expands after crossing the inner end of the cirrus-sac to form a much elongated and very spacious receptaculum seminis

the diameter of which close to its inner end may be as much as 80 μ. This is usually filled in sections with spermatozoa, a stream of which can often be seen passing on into the spermiduct. The beginning of the duct is surrounded by a poorly developed layer of circular muscles which are almost absent from the inner expanded portion. The receptaculum is sharply separated from the spermiduct which has a diameter of only 15 to 30 μ and a length of 0.12 mm. The latter is an almost straight tube passing in the median line from the more dorsally situated receptaculum to its point of union with the oviduct close to the ventral wall of the medulla (Fig. 35). It shows best in transections where its walls are seen to be composed of an epithelium of cubical cells lying on a distinct basement membrane, and to be surrounded with a thick layer of nuclei and extremely few, if any, muscle fibres. The ovary (Figs. 35, 36) is a somewhat kidney shaped tubulolobular organ situated in the posterior half of the proglottis behind the developing uterus-sac with its concavity directed forward and not exactly in the median line but slight approaching the cloaca. It averages 0.45mm. in width by 0.18 in length. The isthmus, which is almost as long and about one half as thick as the wings, is located only slightly below the median frontal plane of the medulla. Ova from the same have a diameter of from 20 to 25 μ. In gravid proglottides where the uterus is filled with eggs only a small portion of the degenerating ovary remains and this is accommodated between the two hindermost pouches of the uterus-sac. The oviduct commences in the median line anteroventral to the ovarian isthmus as a somewhat cylindrical oocapt 40 μ in length by 18 in diameter and

not sharply separated from the rest of the duct (Fig. 35). It passes ventrally with a diameter of 20 μ for about 50 μ before being joined by the spermiduct, and then for only a short distance farther anterolaterally along the ventral transverse musculature before meeting the common vitelline duct. The latter is formed by the union in the usual manner of two vitelline ducts coming from the lateral regions of the proglottis along the ventral wall of the medulla. It is quite short, however, and contains in sections only a limited amount of yolk, its diameter being at the most only 20 μ. The vitelline follicles (Fig. 35) are irregularly ellipsoidal in shape, and situated either just within the transverse muscles, between them and the longitudinal muscles, among the latter or even slightly outside of the longitudinal muscles. While they vary considerably in size and, not being very numerous, are widely spaced, their average maximum diameter is about 50 μ. They form a continuous band completely surrounding the medulla, excepting for irregularly circular areas above and below the ventral ducts and organs, in the median line, but are not continuous from joint to joint. On the whole they remind one of the vitellaria of <u>A. crassum</u>. The union of their efferent ductlets can be easily traced, especially in frontal sections of younger proglottides, since they are comparatively large and hence quite distinct. In gravid proglottides they have, like the ovary, all but disappeared, their function having been almost completely performed. The shell-gland is a small compact organ, about 115 μ in width by 55 μ in length, surrounding the oviduct just beyond the entrance of the vitelline duct, or to be more exact, just beyond the first turn taken by the latter

in its return to the median line after passing laterally, as above stated. It is thus situated ventrally and a short distance from the median line. Beyond the shell-gland the oviduct continues as the uterine duct which makes only a few dorsoventral coils near the median line before emptying into the uterus-sac. The latter is formed in development by the gradual enlargement dorsally of that portion of the duct which traverses the cortical parenchyma on the ventral surface of the proglottis. Just before eggs appear in the sac this part of the tube can be seen in transections as a spindle-shaped dilatation, whose nucleated epithelial wall is surrounded by a thick layer of nuclei, the whole being, however, not distinctly separated from the proximal portion of the tube (the uterine duct of older stages) at a constriction just within the transverse musculature. In proglottides farther ahead this constriction is outside of the transverse muscles in the cortex, so that we must look upon the uterus-sac, then, as being formed by a gradual enlargement of the distal end of the uterus as it becomes filled with eggs and not as a sack separated in the rudiments from the proximal uterine tract as in the Ptychohothriidae. In one case where only 5 or 6 eggs appeared in the lumen the uterus-sac had a diameter in frontal sections of 80μ ; in the next segment following it was enlarged in all dir ctions, somewhat elliptical in outline, with a diameter of 240μ ; in the next still larger; and in the fourth somewhat pointed anteriorly. From then on it quickly enlarged until finally it is a capacious sac, as much as 1.0mm. in diameter occupying the whole of the dorsoventral diameter of the medulla and almost all of the longitudinal and transverse

diameters in gravid proglottides. While as seen in transverse sections it is almost entire in outline, in frontal sections it is divided into from 5 to 8 large irregularly shaped lobes or diverticula, the hindermost two of which enclose the remainder of the ovary and the central connections of the reproductive ducts, as above mentioned. Ventrally the sack is funnel-shaped towards the small opening which only appears when the proglottis becomes quite gravid. Since the uterus-sacs, even the most gravid ones are not situated exactly in the median line but towards the margins bearing the genital cloacae, the openings form " ... a zig-zag line of minute pores [which] traverses the median region of one of the broad faces of the strobila, each pore being near the middle of its segment." Linton correctly considered them to be for the escape of the eggs. Anteriorly where the uterus-sacs do not yet contain eggs these pores, -- in reality the ventral funnel-shaped portions of the sacs, -- are located about 0.18mm. on each side of the median line, but posteriorly they are relatively much closer together, in fact almost exactly in the median line. Furthermore, they are directly opposite or slightly behind the level of the genital cloaca. The opening is formed only when the proglottides become quite gravid by the rupture of the body wall in a very small and limited area, but not of a preformed membrane as in the Ptychobothriinae.

Concerning the eggs Linton (p.433) said: "The ova are nearly spherical, with thin shells. They are about 0.04mm. in the greatest diameter." Those from the material preserved in formalin were found by the writer to be sometimes spherical in

shape but usually ovoid or ellipsoid, with maximum dimensions in the latter case of 45 x 36 μ. Neither in sections nor in preparations of eggs from the uterus sacs of material in formol, alcohol or cleared in oil of wintergreen were opercula to be found, but at the one pole of the egg a small boss about 5μ in diameter which is often enlarged to form a distinct projection or appendage. Altho development had not progressed in any of the eggs studied so far that the six hooks of the oncosphere were visible, the writer is of the opinion that even in mature eggs no opercula would be found, since its almost spherical shape and the presence of the button-like thickening at one pole are quite like conditions in the nonoperculate egg of <u>Abothrium rugosum</u>, for instance, as described and figured by Schauinsland (1885 : 527) and further, since in the egg of the operculate type, as in that of <u>D. latum</u> or of <u>T. nodulosus</u>, described and figures by the same writer, the operculum is present long before the hexacanth embryo has developed.

As regards the life-history of this species nothing is as yet known. It is noteworthy, however, that very young larvae, such as shown in Figs. 29 and30, can be easily recognized on account of the peculiar character of the scolex, so that it would not seem difficult to pick them out of the intermediate host, whatever that may be. All sizes from the youngest (Fig. 29) to the largest were present in the material studied.

The material of this species consisted of Nos. 4724 and 4783 U.S.N.M. Coll., Nos. 16.292, 16.421 and 17.11 C.U.Ill and No. 154 of the writer's collection, all from the intestine of <u>Polyodon spathula</u>, the Paddlefish.

Subfamily 5. TRIAENOPHORINAE Luehe, 1899.

Scolex armed or unarmed, always with two typical and not very deep bothria, ahead of which the flattened termination of the scolex projects more or less prominently in the form of a ring. External segmentation present or absent, in the former case an unjointed neck being absent. Opening of cirrus and vagina marginal, irregularly alternating; uterus opening surficial, ventral, ahead of the marginal genital aperture. Genital apparatus always single in each proglottis. No muscular bulb (Eschricht's body) on the inner end of the cirrus-sac. Receptaculum seminis comparatively small, not always sharply separated from the narrow inner end of the vagina. Uterus a much coiled canal, which while never forming a rosette is usually somewhat enlarged before its opening.

Sexually mature in the intestines of fishes and marine turtles; larval conditions mostly unknown.

Type genus: Triaenophorus Rudolphi, 1793.

Genus 1 Triaenophorus Rudolphi, 1793.

Vesicaria, Cysticercus et Taenia (omm.part.)	Auctorum.	
Triaenophorus vel Tricuspidaria	Rudolphi	1793 : 44
Tricuspidaria	"	1793 : 43-44
Triaenophorus	"	" : 44
Rhytelminthus (part.)	Zeder	1800 : 317
Rhytis (part.)	"	1803 : 391

Tricuspidaria	Rudolphi	1802 : 99-102
"	"	1809 : 7, 25-26
Triaenophorus	"	" : 25
Tricuspidaria	"	1810 : 32
"	Lamarck	1816 : 169
Triaenophorus	Rudolphi	1819 : 135, 467, 598
"	Creplin	1839 : 295
"	Dujardin	1845 : 625
"	Diesing	1850 : 604
"	Baird	1853 : 93
"	Molin	1858 : 134
"	"	1861c: 236
"	Diesing	1863 : 246
"	Olsson	1867 : 56
"	Loennberg	1889 : 41
"	Olsson	1893 : 20
"	Luehe	1899 : 37-38
"	"	1899a: 713
"	Braun	1900 : 1694
"	Luehe	1900a: 98
Tricuspidaria	Stiles and Hassall	1902 : 22-24
Triaenophorus	Luehe	1910 : 23

Generic diagnosis: Scolex armed with four three-pointed hooks, never replaced by a pseudoscolex. External segmentation completely absent. Longitudinal nerves dorsal to the cirrus-sac and vagina, close to the lateral borders. Testes between the

nerve strands only, filling up the whole medullary parenchyma, so far as this is not occupied by other organs; a testis free middle field is quite as infrequently present as a pronounced dorsal layer of the testes. Coiling of the vas deferens in its proximal, almost medially situated part, that portion passing distad to the cirrus-sac very slightly coiled. Vitelline follicles form a continuous mantle between the subcuticula and the longitudinal musculature, which is broken only at the places where the genital ducts open. Ovary, approaching the lateral border bearing the genital openings, lies on the ventral transverse musculature, yet individual ovarian tubules extend partly thruout the whole medulla. Shell-gland just as infrequently median as the ovary, lying behind it, also usually approaching the dorsal surface somewhat. First portion of the uterus only a weakly coiled canal (uterine duct) which passes thru the proglottis transversely and leads into a large single cavity (uterus-sac) which lies not exceptionally ahead of, but yet partly near the ovary, and usually not median but away from the margin bearing the genital openings. The latter also applies naturally to the uterus-opening which breaks thru later. Eggs thick-shelled, operculate.

Type species: _T_. _nodulosa_ (Pallas, 1781) Rud., 1793.

Altho, as indicated in the above synonymy and as contended by Stiles and Hassall (1902d : 23-24), Rudolphi should not have changed the name of the genus in 1819 from _Tricuspidaria_ to _Triaenophorus_ again, after having used it in connection with the specific description in 1810, the change has become so firmly es-

tablished in the literature that it does not seem perhaps justifiable to revert to the older name Tricuspidaria which is known to only a comparatively small group of zoologists.

Triaenophorus sp.larv.
(Figs. 31 – 37.)

Since all of the material at hand was larval, not even the earliest traces of the reproductive rudiments showing in toto preparations of the largest specimens, it was, of course, impossible to determine the species with certainty.

Two types of scolices were present, however, and these agreed with the descriptions of the organ given by various authors for T. nodulosus (Pallas) and by Olsson (1893 : 30-31) and Fuhrmann (1910 : 38-39) in particular, for T. robustus Olsson. It will be seen also in the table below that these two forms were found respectively encysted in the liver, on the visceral organs or in the wall of the stomach, and free in the intestine of the hosts, -- or so firmly attached to the wall as to be deeply imbedded, the mucosa forming a protruding collar around the worm, -- the only exception being those from the intestines of Esox masquinongy and Stizostedion vitreum (vide infra). Olsson pointed out that these two species can be readily differentiated from each other on account of the situations in which they undergo their development. Whereas the larvae of T. nodulosus are found generally within cysts in the liver of the intermediate hosts, as recorded by a number of writers, those of T. robustus are constantly encysted in large numbers in the flesh, -- Olsson having found them in Coregonus albula and C.

lavaretus, Luther (1909 : 58) in C. albula, and Fuhrmann in the "brochet" (? Esox lucius).

The scolex of the robustus type, shown in Figs. 31 and 32, is, as described by Olsson, in the form of a truncated rectangular pyramid, that part immediately behind the terminal disc being considerably constricted and more nearly elliptical in transverse section. As stated by Fuhrmann, "La limite posterieure du scolex de T. robustus est nettement marquée et les deux bothrias, l'un dorsal l'autre neutral, son très profonds ... " This delimitation of the scolex is emphasized by the fact that immediately behind the posterior border of the bothria the dorsal and ventral surfaces of the body of the larva are distinctly concave as are also the lateral surfaces, quite diagrammatically, in fact, as shown in the figures. These concavities extend farther back for a few millimeters and then gradually flatten out and pass insensibly into the convexities which together form the elliptical outline of the cross-section of the middle of the larva. And the writer would like to emphasize here that this was found to be a constant feature of all the material studied and not simply due to any possible local collapsing during dehydration. Altho, as shown in the table the measurements of the whole scolex are much smaller than those given by Fuhrmann, as might be expected, it is chiefly the structure and size of the trident of hooks that led the writer to consider this type of larva to belong to T. robustus. Fig. 33 of one of these compares very favorably with those shown in Olsson's Figs. 31 and 32 and Fuhrmann's Fig. 2, while the measurements (see table) quite agree with those given by the latter. The base of the trident

is comparatively long or deep (in the sagittal direction), hence the specific name according to Olsson, while not only the full length of the larger hooks but also a good deal of the median ones project thru the cuticula as the functional tips; in Fig. 33 which is from an alcoholic specimen these are seen to be darker than the basal piece. The following measurements are given for comparison with Fuhrmann's of adult specimens, which are placed alongside, the data in parentheses being of the opposite trident on the same surface of the scolex in question:

	163.1	163.2	15.47	360.1	After Fuhrmann
Length	147.5mm.	133.0mm.	35mm.	73mm.	310-370mm.
Breadth	1.07	1.16	1.11	1.01	4-4.5
Length of scolex	0.98	0.96	1.07	0.88	1.14-1.3
Breadth of term. disc.	0.77	0.83	0.68	0.74	0.95
Breadth scolex posteriorly	1.05	1.07	1.11	1.11	1.4-1.5
Width trident	0.31(0.30)	0.30(0.30)	0.26	0.25	0.28-0.32
Length, mediad	0.25 (0.24)	0.23(0.23)	0.22	0.23	0.24-0.28
" externally	0.18(0.18)	0.16(0.18)	0.18	0.18-	0.18-0.2
Measured in	O.W.	O.W.	Toto	Alcohol	

Olsson spoke of the larva of _T_. _robustus_ being provided with a narrower cylindrical "cauda" as in certain _Tetrarhynchus_ larvae, and gave the length of one as 120mm., while the anterior portion was approximately 60mm. long. In only a few of the larger larvae at hand were the remains of such a structure seen posteriorly, while in lot No.36 (vide infra) many had appendages of varying lengths and degrees of distinction from the fore-body, a medium large one,

for instance, having these measurements: Length of anterior portion, 48mm., of cauda 24, of scolex, 1.16; width of fore-body, 0.36, of cauda, 0.37 (3 : 1, -- Olsson).

On the other hand, the other type of larva which was considered by the writer to belong to T. nodulosus, is characterized by a much shorter, narrower body smaller at irregular intervals, owing to differences of contraction, into nodules, whence the specific name, and by a quite different scolex provided with the well known form of trident (Figs. 34 to 37). While the latter and the scolex as seen in surficial view agree in essentials with the descriptions and figures given by various authors, e.g., Rudolphi (1810 : 32-37, Tab. IX, Figs. 6-11), Wagener (1854 : 26-27, Tab. 3, Figs. 17-31), Olsson (1893 : 30-31, Figs. 28-33) and Fuhrmann (1910 : 86-89, Fig. 1), it cannot be said of the material at hand that, as stated by the last writer, " ... chez T. nodulosus on ne peut voir aucune limite entre le scolex et le cou du Bothriocephale ... " For in lateral view (Fig. 35) the bothria are distinctly separated from the beginning of the body, altho this is, as just mentioned, not nearly so apparent in surficial view. As shown in Fig. 34, the middle hook of the trident does not protrude thru the cuticula, since it is the root for muscular attachment, the upper median hook (cf. Wagener) which does protrude in the adult, being evidently not yet developed (Figs. 36 and 37). For a short distance behind the scolex the body is somewhat rectangular in cross-section, the sides of the rectangle being, however, slightly convex and not concave as in the robustus type, and hence not so very different from the cross-section of the body and farther

back. But the material contained in lot No. 53 from the intestine of Esox masquinongy does not strictly answer this description since the body just behind the scolex is slightly concave on all sides. Otherwise the specimens are distinctly of the nodulosus type. It should be mentioned, too, that one of this lot showed a very short but distinct caudal piece, which with the general stout appearance of all of them may be accounted for by the possibility that they have reached the intestine of one of their final hosts, -- altho no other specimens were taken from the Maskinonge, -- and continued their development. Likewise a few of the specimens of lots Nos. 10213 and N.B. 28a (vide infra) were provided with short caudal appendages. The smallest example of this type and of all the material, for that matter, at hand was No. 188 of the accompanying table. Altho it is only a little over two and a half millimeters in length, its posterior end shows that a portion, perhaps a caudal piece, has been torn away. The following table gives measurements of a number of specimens of the nodulosus type, similar to those given above for the robustus type, with Fuhrmann's data for comparison:

	133	53	171	188	After Fuhrmann
Length	Piece	Piece	Piece	2.68	130-180
Breadth at Middle	0.61	0.37	0.42	0.30	2.5-4
Length of scolex	0.82	0.63	0.55	0.55	0.95
Width term. disc.	0.43	0.35	0.37	0.31	0.37-0.47
" scol. post'ly.	0.64	0.37	0.37	0.26	0.57-0.6
" trident	0.10	0.15	0.15	0.13	0.135
" " medially	0.14	0.13	0.11	0.14	0.073
" " externally	1.11	0.09	0.08	0.10	0.062
Measured in	O.W.	O.W.	O.W.	O.W.	

It will be noticed that in spite of the fact that all of the measurements of the tridents are larger than those given by Furhmann, they are considerably smaller than those of the other type.

Finally, altho no specimens of either type of larva so young that the hooks had not yet developed, were met with, those of lot No. 40 from the intestine of Stizostedion vitreum were provided with only very small tridents of the nodulosus form, the bases of which were not yet well developed, while the whole scolices were a sort of compromise between the two types in shape but of the nodulosus type as regards size, as shown in the following measurements: Length, 12mm.; width at middle, 0.64; length of scolex, 0.87; width of terminal disc 0.64, same of scolex posteriorly, 0.80; width of trident, 0.14, length medially, 0.07, externally 0.05. Altho these specimen would seem to represent an intermediate stage between the two types of scolex, so far as the general shape is concerned, the writer was inclined to consider them as belonging to the nodulosus type, yet it must be said that smaller scolices, e.g. No. 151 of the table, have considerably larger hooks.

On the whole, then, the bulk of the evidence given here tends to show that here in America we have probably two species, very closely related to if not identical with the European T. nodulosus and T. robustus which have been clearly distinguished by Fuhrmann (1910) and also recognized by Luehe (1910 : 33). However, none have as yet been reported for this continent, so far as the writer is aware.

The material studied is here listed as a host record also:

Lot	Host	Location	Locality	Collector
Type robustus:				
36	Esox lucius	Intestine	Flat-Rock L. Muskoka, Ont.	Cooper
36a, 36b	"	"	Go-Home R., Muskoka, Ont.	"
36c	"	"	Go-Home Bay	"
163	"	? "	"	"
183	"	"	"	"
184	"	? "	"	"
161	"	?	"	"
163	Lota maculosa	Intestine	Off Giant's Tomb Id., Georgian Bay, Lake Huron.	"
15.47	"Lake Herring"	? "	Lake Superior	H.B.Ward
Type nodulosus:				
71	Perca flavescens	In liver	St. Lawrence R., Iroquois, Ont.	Cooper
151	Micropterus dolomieu	On viscera	Go-Home Bay	"
188	Micropterus dolomieu	"	"	"
195	Catostomus commersonii	?	Georgian Bay	"
Fh2b	Notropis delicatus	?	Charlevoix, Mich.	H.B.Ward
10313	"White Bass"	Liver	?	"
N.S.28a	Stizostedion canadense	Stomach wall	New Baltimore, Mich.	"
40	S. vitreum	In intestine	Flat-Rock L.	Cooper
33	Esox masquinongy	" "	Go-Home R.	"

Family 2. PTYCHOBOTHRIIDAE Luehe, 1902.

Scolex unarmed, with two separate and more or less strongly developed bothria or exceptionally replaced by a pseudoscolex. Neck absent. External segmentation never absent, but frequently incomplete or obliterated thru secondary foldings. Genital organs numerous, but only single in each proglottis. Both surfaces of the chain of proglottides, apart from the genital openings similar. Cirrus unarmed, with cleft cuticula. Opening of cirrus and vagina behind the uterus opening, surficial or marginal, in the first case on the opposite surface to the uterus-opening and almost median. No muscular bulb at the inner end of the cirrus-sac. Receptaculum seminis, when present, has the form of a small bind sack situated at the inner end of the vagina. Ovary and shell-gland median. Testes in two lateral fields. Uterus never taking the rosette shape, but usually forming a capacious undivided uterus-sac. Eggs thin-shelled, without opercula; embryonic development in the uterus and in consequence of exhaustic production of eggs (but dependent on the time of year in the case of many species) all the eggs of the whole tapeworm are at the same stage of development.

Sexually mature in the intestine of fishes; larval condition unknown.

In his first diagnosis of the family Luehe (1902a : 326-327) emphasized the similarity of both surfaces of the strobila (on contradistinction to conditions in the Acanthophallidae), the unarmed cirrus with cleft cuticula, the peculiar coecal recepta-

culum seminis and the absence of opercular in the eggs, but described the uterus as follows: "Uterus nie die sogenannte Rosettenform annehmend, wohl aber in der Regel eine geräumige Uterushöhle bildend, welche die übrigen Genitalorgane, ohne dass freilich deren Rückbildung eintritt, buchstäblich an die Wand drängen kann, indem die ganze Proglottis in reifen Proglottiden vielfach als ein einziger sackförmiger Eibehälter mit verhältnismässig sehr dünnen Wandungen erscheint." On account of the fact that the uterus of Haplobothrium was found to answer this description in that it is divided into a uterus-sac and uterine duct, while the remaining reproductive organs are distinctly diphyllobothriidian in their nature, the writer pointed out the difficulties in this connection by saying (1914a : 3) : "As a matter of fact the whole question of the division of the uterus into distinct regions is one concerning which we cannot come to any definite conclusions since, to my knowledge, there is no adequate description of the developmental relationships between the uterine tube and the uterine sac in those genera in which they appear." The conditions in Haplobothrium and Marsipometra have already been discussed above. Here will be given the observations on the development of the uterus to which reference was made.

In Bothriocephalus scorpii the lumen of the uterus-sac appears suddenly and with a diameter of 90μ, the rudiment ahead showing as yet no signs of forming a cavity. This enlargement is situated at first, however, in the cortical parenchyma and among the longitudinal muscles, only the inner tip of the structure in transsections going into the medulla. Just within the inner transverse

muscles this inner portion of the sac is joined by the uterine duct which with a diameter of 30 μ elsewhere is here only 8 μ in diameter. Furthermore in the genital rudiment of the next proglottis ahead there is a distinct demarcation between the aggregation of nuclei that will form the sac and the axial rudiment of the uterine duct. The same separation of sac and duct with the narrowing of the latter just before entering the former is present in the following segments even where the first eggs are to be seen in the lumen. Thus the eggs must have passed this narrowed region which is a great deal smaller than their diameters. Still farhter back where the lumen is about 165 μ in diameter there can be seen not only the situation of the sac in the cortex and among the longitudinal muscles, projecting as yet only a short distance into the medulla, -- altho here the bundles of muscles are deflected peripherally, -- but also the separation of the two parts by a narrow neck only 10μ in diameter. _B_. _cuspidatus_ shows the same distinct separation of the uterine duct and uterus-sac in the proglottides where there are already a few eggs in the latter. In _Clestobothrium_ _crassiceps_ conditions were found to be quite the same. When the lumen of the sac attains dimensions of about 60 x 35μ and is lined with an epithelium which takes the conterstain more like a cuticula but shows distinct nuclei on its surface towards the lumen, the uterine duct opens into it with a distinct reduction in diameter. The epithelia of the two are, however, quite similar and continuous, the nuclei being located in a similar manner in both. Proglottides ahead show that the sac is formed by an enlargement of the end of the duct, which takes place first in that region passing thru the cor

cortex quite as in Bothriocephalus.

Thus we see that the uterus sac of this family is quite different from the functional enlargement of the uterus of the Diphyllobothriidae, with the exception of that of Haplobothrium, since at all stages in its development it is sharply separated from the uterine duct. But as it was not so much this exact separation of the two portions as the constant presence of a "Uterushöhle" in this family and its absence in the other, where the "Rosettenform" is more common, that was emphasized by Luehe, and since the structure in Haplobothrium is distinctly ptychobothriidian in character, the functional enlargement of the uterus can not now be considered to be of such systematic importance as was formerly believed to be the case.

Subfamily 1. PTYCHOBOTHRIINAE Luehe, 1899.

Scolex with two surficial sucking grooves, which may be modified by considerable growth together of their free edges. Genital openings surficial, those of the cirrus and vagina dorsal, that of the uterus ventral and ahead of the other two. Vas deferens strongly coiled, dorsal. Ovary ventral; shell gland dorsal. Vitelline follicles usually in two lateral fields in the cortical or medullary parenchyma. Testes completely filling the medulla, mostly marginal to the longitudinal nerves which are well towards the median line.

Occurrence : Exclusively in fishes.

Type genus : Bothriocephalus (Rud.) Luehe.

The above diagnosis lacks the wor ds "seldom armed" after "scolex" which appear in Luehe's latest (1910 : 24) characterization not only of this subfamily but of the family, because they do not appear in his earlier (1899 : 41 and 1902a : 336, respectively) papers, nor does there seem to the writer to be any occasion for their use.

Genus 1. Bothriocephalus Rud.1808,e.p.Luehe 1899, e. p.

Taenia (part)	Auctorum.
Rhytelminthes (part.)	Zeder, 1800.
Alyselminthus (part.)	Zeder,1800.
Rhytis (part.)	Zeder, 1803.
Bothriocephalus (part.)	Rudolphi, 1809.
Bothriocephalus(part.)	Rudolphi, 1819.
Dibothrius (part.)	Rudolphi, 1819.
Bothriocephalus(part.)	Leuckart, 1819.
Bothriocephalus(part.)	Dujardin, 1845.
Dibothrium (part.)	Diesing,1850.
Bothriocephalus(part.)	Baird, 1853.
Dibothrium (part.)	MOlin, 1861.
Dibothrium (part.)	Diesing, 1863.
Bothriocephalus(part.)	Carus, 1885.
Bothriocephalus(part.)	Matz, 1891.
Bothriocephalus(part.)	Ariola, 1896.
Bothriocephalus s.str.	Luehe, 1899.
Bothriocephalus(part.)	Ariola, 1900.
Bothriocephalus s.str.	Braun, 1900.
Bothriocephalus s.str.	Luehe, 1910.

Generic diagnosis: Scolex elongated, with two only weakly developed sucking grooves. Neck absent. External segmentation well developed; between two consecutive genital segments there is always present a saw-tooth notching of the lateral border, yet a corresponding transverse furrow on both surfaces is sometimes lacking. Vitelline follicles in the cortical parenchyma, continuous from proglottis to proglottis, as are the testes. Recepta-

culum seminis absent. Beginning of the uterus a winding canal (uterine duct) which opens into a large nearly spherical cavity (uterus-sac or uterus s.str.). Uterus-opening approximately median, as is the dorsal genital opening.

Type species: Bothriocephalus scorpii (Mueller).

Species 1. Bothriocephalus scorpii (Mueller, 1776)

(Figs. 38 - 49.)

1722	Vermis multimembris rhombi	Leeuwenhoek	1722 : 402.
1776	Taenia scorpii	Mueller	1776 : 219.
1780	Taenia scorpii	Mueller	1780 : 179.
1780	Taenia scorpii (part.)	Fabricius	1780 : 319.
1786	Taenia scorpii	Batsch	1786 : 235.
1788	Taenia scorpii	Mueller	1788 : 5-6.
1788	Taenia scorpii	Schrank	1788 : 48.
1790	Taenia scorpii	Gmelin	1790 : 3078.
1799	Taenia scorpii	Ratke	1799 : 68.
1800	Alyselminthus bipunctatus	Zeder	1800 : 236.
1802	Taenia punctata	Rudolphi	1802 : 109-110.
1802	Taenia scorpii	Bosc	1802 : 307.
1803	Rhytis bipunctata	Zeder	1803 : 296.
1810	Bothriocephalus punctatus	Rudolphi	1810 : 50.
1819	Bothrioc. punctatus	Rudolphi	1819 : 138.
1819	Bothrioc. punctatus	Leuckart	1819 : 40.
1844	Bothrioc. punctatus	Bellingham	1844 : 254.
1845	Bothrioc. punctatus	Dujardin	1845 : 617.
1850	Bothrioc. punctatus	Beneden	1850 : 160.

1850	*Dibothrium punctatum*	Diesing	1850 : 593.
1853	*Bothrioc. punctatus*	Baird	1853 : 89.
1855	*Dibothrium punctatum*	Leidy	1855 : 444.
1856	*Dibothrium punctatum*	Leidy	1856 : 46.
1858	*Bothrioc. punctatus*	Cobbold	1858 : 157.
1858	*Dibothrium punctatum*	Molin	1858 : 134.
1861	*Dibothrium punctatum*	Molin	1861 : 235.
1863	*Dibothrium punctatum*	Diesing	1863 : 240.
1867	*Bothrioc. punctatus*	Olsson	1867 : 14,55.
1878	*Bothrioc. punctatus*	Linstow	1878 : 237.
1885	*Bothrioc. punctatus*	Carus	1885 : 120.
1889	*Bothrioc. punctatus forma bubalidis*	Loennberg	1889 : 32.
1890	*Dibothrium punctatum*	Linton	1890 : 731.
1891	*Bothrioc. punctatus*	Loennberg	1891 : 51.
1892	*Bothrioc. punctatus*	Matz	1892 : 105.
1893	*Bothrioc. punctatus forma motellae*	Loennberg	1893 : 13.
1893	*Bothrioc. punctatus*	Olsson	1893 : 16.
1897	*Dibothrium punctatum*	Linton	1897 : 430.
1899	*Bothrioc. bipunctatus*	Luehe	1899 : 43.
1900	*Bothrioc. punctatus*	Ariola	1900 : 394.
1900	*Bothrioc. bipunctatus*	Braun	1900 : 1691.
1902	*Bothrioc. bipunctatus*	Fuhrmann	1902 : 446.
1902	*Bothrioc. punctatus forma punctatus vel typica*	Schneider	1902a: 14.
1902	*Bothrioc. punctatus forma rhomoi*	Schneider	1902a: 15.
1902	*Bothrioc. punctatus forma cotti-quadricornis* mihi	Schneider	1903 : 75-76.

1910 <u>Bothrioc</u>. <u>bipunctatus</u> Luehe 1910 : 25.

Specific diagnosis: With the characters of the genus. Large cestodes, up tp 950mm. long by 6mm. wide. Scolex, large, elongate, with prominent terminal disc, widest anteriorly; length 1.0-3.5mm., breadth 0.3-0.5. Bothria long and narrow, shallow posteriorly. First segments subcuneate with weakly prominent posterior borders, longer than broad. Middle and posterior segments much depressed, former very short and broad, latter relatively less so and grouped in twos or threes; lateral borders crenulate. Ripe proglottides 2-4mm. wide by 0.2-0.8 long. Strobila usually incomplete posteriorly.

Cuticula 5μ in thickness. Calcareous bodies 13μ in diameter. Inner longitudinal muscles in fascicles. Six chief longitudinal excretory vessels.

Opening of the genital cloaca at the bottom of a dorsal median longitudinal depression ruuning thuuout mature segments, on a low papilla in each proglottis and half way between the anterior and posterior borders. Vaginal opening immediately behind that of cirrus. Distinct ductus hermaphroditicus present.

Testes subspherical, 35-70μ in diameter and 30 t0 60 in number for each segment. Vas deferns a compact mass lateral to cirrus-sac and opposite the uterine tube, 0.18 x 0.10mm. Cirrus-sac at right angles to dorsal surface, 115 x 120 x 75-80 , extending only a short distance into the medulla; thick layer of nuclei within its wall. Cirrus proper, notprotruded, 65 x 15μ .

Ovary compact, tubulolobular, 0.33mm. wide by 0.15 long where uterus-sac is not greatly distended. Isthmus onlyventral. O0capt 35μ in diameter. Vitelline follicles in two lateral weak-

ly united fields on each surface, 350 to 540 in number, 35-55μ in diameter; vitelline reservoir small. Shell-gland large, 115μ wide by 0.85 deep, median, close behind cirrus-sac. Uterine duct voluminous on both sides of the median line, closely applied to ovary behind. Uterus-sac spherical to flattened anteroposteriorly, occupies one-sixth of transverse diamter of proglottis, alternating irregularly from side to side, or often quite median. Opening in middle of sac, ventral and well forward, formed by the rupture of a distinct membrane.

Eggs, 66-80μ in length by 43-45 in diameter, without opercula, forming dark brown maculations in ripe proglottides as they show thru the walls of the uterus-sacs.

Habitat: In the intestine of the host.

Host	Locality	Collector	Authority
Cottus scorpius	Denmark	Mueller	Mueller 1784:6
" "	Gryphswald	Rudolphi	Rudolphi 1819:139
" "	----------	Kais.-konig.-nat'lkab.	Leuckart 1819:40
" "	Ireland	Bellingham	Bellingham 1844:254
" "	"Oresund e Berg,Sweden	Olsson	Olsson 1867:55
" "	Norway	Loennberg	Loennberg 1890:22
" "	Sweden	"	" 1891:51
" "	Grafverna and Näset,Sea of Bahusia	Olsson	Olsson 1893:16
" "	Arctis Ocean	----------	Linstow 1901:281
" "	Gulf of Finland	Schneider	Schneider 1902:15

Cottus scorpius	Murman-Küste	Coll.Zool.Mus. K.Akad.Wiss. Petrograd.	Linstow	1903:19
" "	White Sea	Danilevskij	"	" "
" "	North Sea	Nicoll	Nicoll	1907:70
" "	Firth of Clyde, Millport, Scotland.	"	"	1910:355
" bubalis	England	Cobbold	Cobbold	1858:157
" "	Norway	Loennberg	Loennberg	1890:22
" "	Sweden	"	"	1891:51
" "	Grafverna and Näset	Olsson	Olsson	1893:16
" "	"Oresund e Berg"	"	Ariola	1900:396
" "	North Sea	Nicoll	Nicoll	1907:71
" quadricornis	Gulf of Finland	Schneider	Schneider	1903: 75
Pleuronectes boscius	Naples	Rudolphi	Rudolphi	1819:139
Pleuron. flesus	"Oresund e Berg"	Olsson	Ariola	1900:396
" maximus	Denmark	Mueller	Mueller	1784: 6
" "	Gryphswald	Rudolphi	Rudolphi	1819:139
" "	Ariminus	"	"	" "
" "	----------	Kais.-konig.-nat'lkab.	Leuckart	1819:40
" "	Ireland	Bellingham	Bellingham	1844:254
" "	Langrunne, Rennes	Dujardin	Dujardin	1845:618
"Turbot"	Belgium	Beneden	Beneden	1850:161
Pleuron. rhombus	Naples	Rudolphi	Rudolphi	1819:139
" "	Ireland	Drummond	Bellingham	1844:254

Pleuron. solea	----------	Kais.-konig.-nat'ikab	Leuckart	1819:40
Torpedo narce	Naples	Rudolphi	Ariola	1900:396
" ocellata	"	"	Rudolphi	1819:139
" oculata	----------	Volz	Volz	1900:55
Gadus aeglifinus	Arctic Ocean	----------	Linstow	1901:281
" minutus	Naples	Rudolphi	Rudolphi	1819:139
Arnoglossus boscii	"	"	Ariola	1900:396
" pegosa	Ariminus	"	Rudolphi	1819:139
" solea	----------	Mus.Vienn.	"	" "
Trigla adriatica	----------	C.E.V.	"	" "
" "	Hafnia	Eschricht	Diesing	1850:594
" lineata	Ireland	Drummond	Diesing	1850:594
Psetta maxima	England	Siebold,Coll. Brit.Mus.	Baird	1853:89
Platessa plana	Pennsylvania	Leidy	Leidy	1855:444
" flesus	Germany	----------	Luehe	1910:25
" passer	Trieste	----------	Stossich	1898:116
Rhombus maximus	Italy	Molin	Molin	1858:134
" "	Patavia	"	"	1861 :235
" "	"Oresund e Berg"	Olsson	Olsson	1867 : 55
" "	Trieste	Stossich	Carus	1885 :120
" "	Venice	Ninni	Stossich	1890:7
" "	Warnemünde	----------	Matz	1892:105
" "	Rossitten, Cranz,Memel	----------	Muehling	1898:36
" "	Trieste	----------	Stossich	1898:116
" "	Genova	Parona and Ariola	Ariola	1900:395
" "	Trieste	Stossich	Stossich	1901:97
" "	Gulf of Finland	Schneider	Schneider	1902:15

Rhombus maximus	North Sea	Nicoll	Nicoll	1907:72
" barbue	----------	Volz	Volz	1900:55
" laevis	"Oresund e Berg"	Olsson	Olsson	1867:55
" "	Grafverna and Näset	"	"	1893:16
" maeoticus	Odessa	Nordmann	Linstow	1901:281
Lophopsetta maculata	Martha's Vineyard, Mass.	Linton	Linton	1890:732
Bothus maculatus	Woods Hole	Linton	Ariola	1900:396
" "	" "	"	Linton	1897:430
Hemitripterus americana	-----------	Coll.U.S. Nat.Mus.	"	" "
"	Casco Bay, Me.	"	"	" "
"	Woods Hole	"	"	" "
"	-----------	Coll.Nat.Mus., Wash.	Ariola	1900:396
Limanda ferruginea	Block Id.	U.S.Fish Com.	Linton	1897:430
" "	WoodsHole	Williams	"	1901:284
" "	" "	Linton	Linton	1901:485
Labrus maculatus	"Oresund e Berg"	Olsson	Ariola	1900:396
Motella mustela	-----------	Coll.Mus.Vien.	"	" "
Mullus barbatus	Genova	Parona	"	" "
Solea monochii	-----------	Coll.Mus.Vienn.	"	" "
Acipenser ruthenus	-----------	Volz	Volz	1900:55
Scorpaena porcus	-----------	"	"	" "
Paralichthys oblongus	Woods Hole	Linton	Linton	1901:484
Lota vulgaris	Dvina-Fluss	Danilevskij	Linstow	1903:19
Raja clavata	Black Sea	Pilat	Pilat	1906:191
Anguilla vulgaris	River Dee, Scotland	Scott	Scott	1909:79

Decapterus punctatus	Woods Hole Region	----------	Sumner, Osburn and Cole 1913:586
Hippoglossus hippoglossus	"	----------	" " "
Myoxocephalus aeneus	"	----------	" " "
decimspinosus octodecimspinosus	"	----------	" " "
Palinurichthys perciformis	"	----------	" " "
Paralichthys dentatus	"	----------	" " "
Pseudopleuronectes americanus	"	----------	" " "
Scomber scombrus	"	----------	" " "
Trachurops crumenophthalmus	"	----------	" " "
Urophycis chuss	"	----------	" " "
Hemitripterus americanus	Passamaquoddy Bay, New Brunswick	Cooper	Cooper (the present paper)
" "	Brandy Cove, St.Croix R., N.B.	"	"
" "	Woods Hole	V.N.Edwards	"
? Myoxocephalus aeneus	" "	"	"
? " groelandicus	" "	"	"

As shown in the table of measurements given below most of the specimens of this species ranged in length from 50 to 240mm., while none were considered to be complete posteriorly. The smallest measured 28mm. in length and the largest 677mm. The scolex assumes a variety of forms in prevervved material, but agrees in general with the descriptions of the organ for B. scorpii by all the authors from the time of Rudolphi (1810 : 51). Its commonest shape is shown in Figs. 38 and 39 where it is seen to ne quite elongated, somewhat broader and truncated anteriorly and narrow posteriorly. The anterior portion is in reality in the form of a low pyramid, comparable internally (vide infra) as well as externally with the terminal disc of the Triaenophorinae. Its base is deeply indented dorsoventrally, that is opposite to bothria, but rounded laterally. The whole scolex is broadest at about its middle and narrowest at its posterior end, a portion of which is here considered to be the beginnings of the first segment on account of its being in all the material at hand set off from the rest of the scolex ahead by a more or less definite groove. The bothrium is in the form of an elongated V, being ordinarily widest and deepest just behind the terminal disc and much narower and shallower posteriorly where it is not bounded by a definite wall but spreads out on the base of the scolex. In many specimens, however, the scolex is so contracted and the walls of the bothria so protruded that the latter shows its greatest depth at the middle of the scolex. In lateral view (Fig. 39) the scolex is more oval in outline and a little wider towards the base. From this fact it is conceivable that Mueller's (1784a) Fig. 7 showing a more

"orbicular" scolex in B. scorpii in lateral view may be explained by supposing that he was dealing with a much contracted specimen, altho in justice to the other side of the question, it must be said that the first segments in his figure are by no means contracted. It will be noticed that the figures of the scolex given here agree very closely with that of Scott (1909 : Fig. 3, Pl. V), altho from the fact that he records B. scorpii as having been found in Anguilla vulgaris, it is quite possible that he had in reality B. claviceps (Goeze) which has been found only in eels up to the present, so far as the writer is aware.

Segmentation begins immediately behind the scolex, so that there is no true neck, altho the base of the scolex has the appearance of a very short neck region from which the foremost segments are cut off as soon as they form such in fact being considered to be the case. The anterior part of the strobila, however, serves the purpose of a neck in that it shows a division into subsegments in a manner to be presently described. As regards the habit of the whole strobila and the general shape of the segments, Rudolphi's (1810 : 51-52) description of the species is so applicable to this form that it is given verbatim:

> "Collum nullum. Corpus planum, margine crenato. Articuli capiti proximi plerumque longissimi, augustissimi, subcuneati, margine postico untrinque parum exstante, saepe tamen, praesertim post mortem, contracti, ut reliquis vix longiores apparant. Articuli insequentes anticis breviores et sensim latiores; postici subaequales, fere

quadrati, utplurimum latiores quam longi, interdum quasi ex duobus tribresve confusis compositi, satis magni, margine obtusiusculo hinc inde inciso. Articulus ultimus obtusus.

Linea utrinque longitudinalis articulos majores percurrit. Inter utramque faeturae apparatus."

Leidy (1855 : 444) described the strobila of the B. scorpii which he found in Platesa plana as follows:"Neck none. Anterior segments cuneate or triangular; posterior ones quadrate; each with an appearance of three subdivisions, with the subsegments having a pair of generative apertures, in the course of a longitudinally depressed dark colored line, passing the length of the body,"; which Cobbold (1858 : 157) said of individuals from Cottus, bubalis: "Toward the lower part of the so-called neck, the joints exhibited at the lateral margins indications of division, which become gradually more defined towards the tail." In the same connection Krabbe (1865 : 37) said that, according to Schhricht, "Pendant leur développement ultérieur, l'augmentation du nombre des articles n'est pas toujours exclusivement due, comme chez les Taenias, à la formation de nouveaux articles engendrés par la tête, mais chez quelques espèces, telles que les B. dubius, variabilis et fasciatus (here B. punctatus also) elle est encore produite par la division transversale qui s'opère dans les articles déjà formés." Olsson (1867 : 55) also referred to multiplication of segments by transverse division of older ones. Loennberg (1891 : 53) denied this statement of Olsson's, but as pointed out below the negation is applicable to the posterior mature segments

of this form at least, not to the middle segments referred to by the latter. Linton (1890 :773) said: "Secondary segments appear at about the twelfth segment from the head. These are formed by a division of each segment into two by means of a mddianntransverse line. This is repeated farther back in much the same manner as described under D. microcephalum." In this form such subdivision of segments to form daughter segments was found to occur all along the strobila from close behind the scolex to well into the region showing the median row of reproductive rudiments, and in such a manner that, in the anterior part of the strobila at least, what was considered to be a primary segment, situated between the most prominent transverse furrows visible, became subdivided into 2, 4, 8, 16 and finally 32 divisions, each of the latter accommodating two reproductive rudiments. But it must be emphasized that this method of formation of new segments is only approximately followed out since, as it passes backward in development, the primary segment does not always contain 64 genital rudiments, because in the first place some secondary or even tertiary transverse furrows become almost as prominent as the primary ones, and secondly, because at the same time there is considerable further subdivision not only of the peripheral tissues but especially of the rudiments themselves. Close behind the scolex the primary segments are very short (Fig. 38), the first six to ten being divided only into two subdivisions in strobilae of moderate size, but into three or four subdivisions in the largest chains. Farther back this more or less regular manner of segmentation takes place gradually, but division is usually seen to occur more readily and quickly in the anterior

part of the primary segment or of its major subdivisions, i.e., secondary or tertiary, than in its posterior part, -- sometimes, however, the reverse being the case. Thus in general there is a sort of dominance of the anterior end of the segment, which one might call a zooid in the sense in which Child uses the word, over its posterior end as regards metamerism. While this method of formation of segments is further obscured by the fact that often one seems intercalated among primary segments, showing these features well, others which seem to lag behind in division and are hence younger, and that in much elongated strobilas it is still more difficult to dintinguish between primary and secondary transverse furrows, owing to their being quite smoothed out especially medially, the whole plan is sufficiently clear to warrant its being described with the definiteness here given. Figs. 40, 41 and 42 will give a better idea perhaps of the whole method of segmentation than this description. While in Fig. 40 the primary segments are indicated by asterisks, in Figs. 41 and 42 the whole drawing is in each case that of a primary segment. Under the heading of the reproductive system below it will be seen that in the mature portion of the strobila the most prominent transverse furrows are described as coming approximately every eighth or sixteenth genital segment. This is due to the fact that the secondary and tertiary furrows, respectively those dividing the primary segments into two then four parts, become quite as pronounced as the primary ones, thus making it impossible to follow this system of segmentation beyond the region of differentiation of the genital rudiments.

At least three prominent longitudinal grooves run thruout the median and posterior portions of the strobila on each surface, even cutting thru the posterior borders in many places, but their course is not regular; they are accompanied by numerous other shorter and more irregular grooves; all of which, however, do not seem to be due simply to lateral contraction of the segments. The following table gives a list of measurements of representative specimens in alcohol from the material at hand.

Number of specimen	196.1	196.2	196.3	196.4	197	198.1*	198.2*
Total length	234	173	103	51	677	233	180
Length of scolex	1.20	1.07	0.81	1.14	1.11	5.00	0.85
Breadth of terminal disc	0.30	0.33	0.26	0.33	0.28	0.29	0.27
Breadth at middle	0.35	0.32	0.30	0.37	0.31	0.11	0.22
Breadth at base	0.28	0.27	0.24	0.35	0.26	0.11	0.16
Length of Seg. I	0.14	0.16	0.09	0.18	0.33	1.83	0.44
Length of Post. Seg.	0.85	0.46	0.35?	0.57	?	0.54?	0.81
Breadth of same	1.83	1.12	0.53?	0.92	?	1.70	0.99
Maximum breadth of strobila	2.50	1.60	1.05	1.57	3.35	2.80	1.51

*Stretched during fixation.

Since Loennberg (1891 : 52) described the cuticula of the species there has been no mention of this tissue in the literature so far as the writer is aware. In sections it was found to be 5μ in thickness and composed of two layers, the outer of which is about two-fifths of the whole thickness and is made up of rather stout, closely set "cirri" which stain much more readily than does

the inner more homogeneous and lighter layer. These cirri seem to lie on a distinct membrane since their proximal (central) ends are all even and distinguishable in some places as dark granules. In sections stained more deeply than those which show the inner layer as a single homogeneous stratum, the latter is divided into two layers, the outer of which is less deeply stained than the inner and about one-half as thick or one-fifth of the thickness of the whole cuticula. The wavy nature of the cuticula and the basement membrane were found to be as described by Loennberg, but in many places the membrane is separated from the cuticular musculature by a very thin clear space barely distinguisheable with high powers. The cuticula covering the scolex was found to be about 4 μ thick, the difference between it and that over the proglottides being due to a thinner homogeneous stratum. The outer layer of the cuticula is not modified to form spinelets on the posterior borders of the proglottides, as in C. crassiceps (vide infra), nor on the edges of the terminal disc, but the pseudocilia are somewhat longer and relatively stouter on the scolex and anterior segments than elsewhere.

The subcuticula, from 25 to 30 μ in thickness, has the nuclei of its spindle-shaped cells arranged at various levels so that the space between the cuticula and the vitelline follicles is, excepting for its outer one-third, well filled with them (Fig. 43).

The chalk-bodies,described by Loennberg were not studied in living material, but spherical spaces which were occupied by them before they were dissolved out by the acetic acid of the fixing agent, were found to be more numerous, as Loennberg stated, in the

cortical than in the medullayy parenchyma. In the scolex they are somewhat more numerous than in the strobila, in both of which locations they attain a diameter of 13μ.

Loennberg (1891 : 53) gave a good description of the musculature of the species, while Luehe (1897a : 747) referred to that of the posterior border of the proglottis in the discussion of the arrangement of the muscles of the whole order. In addition to corroborating the findings of these authors it was noticed that the fibres of the transverse series are mostly confined to the very short regions between the sets of reproductive organs and are most numerous just ahead of the prominent segmental furrows mentioned above, this applying to both the inner and outer lots. Towards the median line each layer of longitudinal muscles is about 35μ in thickness and composed of bundles of various sizes in which the fibres are very closely arranged. The outer longitudinal muscles, the extension of which into the posterior borders of the segments immediately behind the scolex are only weakly developed, are confined in the scolex almost completely to very thin bands situated close to the cuticular musculature in the edges of the bothria, as described elsewhere by the writer (1914b : 92) for _H_. _globuliforme_. There is also a weak series of longitudinally arcuate fibres arranged around the edges of the terminal disc as in the latter.

Loennberg (1891 : 54-56) described the nervous system so well that little needs to be added. It was noticed that the foremost four large branches from the brain complex were not relatively as large as those shown in Loennberg's Fig. 1a, and that the commissure appeared to be divided into two not distinctly separated

frontal strands, the whole depth of which, including the space between them, was not as much as that shown in his Fig. 1c. In the strobila the chief nerve strands, each from 15 to 25μ in diameter, were found to be situated towards the ventral side of the medulla and at the junctions of the lateral and median quarters of the latter, as shown in Fig. 43.

The excretory system of B. scorpii was described in detail by Fraipont (1881 : 8-12), while Loennberg (1891 :53-54) added some further notes on its structure, the former, however, working on living material in which the canals are much more readily seen. In good toto preparations the "canaux descendants" may be easily seen in segments showing the reproductive rudiments as well as farther forward. Owing to a mere accident, temporary preparations were made with more or less constant success, showing the details of the reticulum of descending canals in great detail. When some pieces of a strobila were being transferred from synthetic oil of wintergreen to a slide for the preparation of toto mounts by the further addition of xylol-damar, they suddenly became opaque white and remained so for some time after the damar and cover-glass had been added. This opacity was found to be due to air having been drawn into the excretory canals not only thru their cut ends but thru the foramina secundaria. But since the superficial reticulum and all the finer canals were filled with air, nothing of the arrangement of the larger canals could be made out until a short time had elapsed or until the preparation had been heated slightly. Then the air in the smaller canals became replaced by the xylol-damar or become dissolved in the latter, and the larger-canals

stood out as very distinct silver threads. This sort of preparation is unfortunately not permanent, since after a few minutes all of the canals disappear, excepting the largest which can still be followed as in ordinary toto mounts. The results of this somewhat uncertain method of demonstrating the excretory canals are shown in Fig. 44, a camera lucida drawing made while the canals were quickly disappearing from view. Three of Fraipont's large "canaux descendants" can be seen together with much of the anastomes among them and at least two branches to foramina secundaria. The largest and most median canal was found to have a diameter of 50μ. But contrary to what was stated by Fraipont (1881 : 9,11) only six of these main channels were found close to the ventral layer of longitudinal muscles in the medual lary parenchyma and not six for each face. Loennberg stated, correctly it seems to the writer, that their number is very variable as is their size and course, the whole forming a complicated reticulum showing the typical "island formation". As regards the termination of the excretory vessels at the posterior end of the strobila the writer was able to confirm Fraipont's 1881 : 10-11) statement that: "Chez un sujet qui a déjà perdu des proglottis, les gros canaux longitudinaux sont rompus au niveau du bord libre postérieur du dernier segment. Les uns communiquent directement avec l'extérieur, les autres ne sont renfermés et se terminent en cul-de-sac;" but no cases were met with in the material at hand in which it could be considered that no segments had been lost. Towards the scolex the six vessels gradually come closer and closer together until in the first segments they may appear for short distances in two sets of

three each, dorsoventrally situated, but soon again become lost in their anastomases. Entering the scolex four, three, or two main canals may be seen, but here they cannot be followed as such thru many sections since they soon break up into the recitulum mentioned by Fraipont as ramifying thruout the scolex.

Of the generative organs the earliest writers were able to discern only the external openings ("oscula" and the uteri which, showing their contained dark brown eggs thru the body wall as a longitudinal series of dark punctations, gave origin to the specific names of Zeder (1800) and Rudolphi (1802 and 1910). Concerning these characters Mueller (1788 : 6) wrote as follows:

> "Margines corporis depressi intersectione articulorum crenati apparent; oscula in anterioribus articulis nulla adsunt, in posterioribus vera altera in pagina pori in macula albida nigricantes, in altera papilla alba subelevata, punctaque seu globuli utrinque dispalati, qui ovula. Oscula seu pori non seriem rectam in corpore. Taeniae sed hinc et illinc divergentem constituunt, alterum in centro articuli, alterum in intersectione constitutum. Articuli postici reliquis latiores punctis utrinque dispersis medio autem coacervatis papillulamque exhibentibus repleti sunt; harum coacervatio oculo nudo punctum centri nigrum offert, armatus vero ovula seu globulos e membrana ovata pellucida punctulis nigricantibus impleta constantes discernit".

Rudolphi (1810 : 50) described them in these words:

"Singuli enim articuli in superficie dorsali nodulum orbicularem, simplicem vel duplicem, subelevatum, vel albidum vel fuscescentem ant nigrescentem exhibent; in superficie autem ventrali nodulus simplex vel duplex, pariter, sed minus, exttans, quasi perforatus videtur; corporeque pellucido nodulis illis linea corporis media, plerumque tamen irregularis oritur. Noduli aperti ovaria sistunt, ovisque ellipticis mediocribus referti sunt, haec etiam saepe circa eosdem effusa sunt."

From these descriptions it is to be seen, incidentally, that while Mueller made correct observations concerning the relations between the positions of the genital openings and the transverse furrows mentioned above, Rudolphi considered the ventral surface to be that on which the openings of the cirrus and vagina are situated and the dorsal that on which the uterus opens to the exterior. Van Beneden (1850) seems to have been the first writer to describe the anatomy, with, however, some errors of interpretation as pointed out by Loennberg (1891e). After Loennberg's the best and practically the only description of the genitalia was given by Matz (1892 : 105-108), Ariola (1900 : 394-7) and Luehe (1910 : 25) obviously copying in part at least from him.

The earliest traces of the reproductive rudiments appear in toto mounts of this form about 35 to 40mm. from the tip of the scolex. From this region backwards they increase in size, but so slowly that in large strobilas there may be an intervening

stretch of at least 225mm. before the genital sinus appears. Then the rudiments differentiate very quickly, the first eggs appearing in the uterus-sac about 2mm. farther on in one toto mount made. In the largest strobila at hand (no. 197 above) the first genital sinuses were seen, when the worm was examined in alcohol, about 375mm. from the tip of the scolex and the first traces of eggs showing thru the ventral body wall about 20mm. farther on.

Van Beneden (1850 : 162) seems to have ben the first to mention the relations between the external segments and the sets of reproductive organs. He said: "Dans chaque anneau, il y a deux on trois appareils mâles et femelles complets ; je pense que ces anneaux se divisent encore plus tard, de manière à n'avoir plus qu' un appareil dans chaque animal," -- (the "animal" is evidently a misprint for "anneau"), -- and further in his footnote referring to the superscript after "complets": "J'ai vu des anneaux qui en contenaient jusqu'à Six." In his Fig. 4, Pl. XXI, he showed four parts of the strobila containing evidently three or four sets of reproductive organs in each segment, with the latter subdividing so that two sets appeared in each subsegment in the fourth part of the figure. Leidy (vide supra) described the posterior segments of B. scorpii as " ... quadrate; each with an appearance of three subdivisions, with the subsegments having a pair of generative apertures, in the course of a longitudinally depressed, dark colored line, passing the length of the body." Linton (1890 : 733) referred to "the phenomenon which the posterior segments present of being welded together in groups of three or

four, an appearance which is quite characteristic of the posterior segments and which has been alluded to in various descriptions of the species," while further, in connection the apertures of the reproductive organs: "In the middle of the strobila there sometimes appear to be as many as four or more papillae to a single segment," and with reference to the specimens from Lophopsetta maculata: " ... toward the posterior end of the body the adult segments are arranged in groups of from four to six simple segments, as if the latter were partially fused together, which is another characteristic of this species." From these statement and the further fact that the posterior proglottides have been described as trapezoidal (Stossich), quadrate (Rudolphi, Linton), subquadrate (Diesing), or at most, broader than long (Rudolphi), -- actually about twice as broad as long from Linton's (1890 : 733, 734) description, -- it is evident that the groups of four sets of reproductive organs (much less frequently three, five or six) shown here in Figs. 42, 45 and 46, and separated from each other by grooves which in alcoholic material appear to be complete, have been considered to constitute the ripe proglottides. But, as pointed out by Loennberg, the lesser transverse furrows are only "greater wrinkles or foldings of the surface" and do not cut in deep enough to cause the parts immediately ahead to stand out distinctly like the posterior borders of the proglottides of other species, e.g., C. crassiceps. Such posterior borders, with their accompanying "complete" transverse furrows, do occur, however, but only at considerable intervals. One case is shown in Fig. 47, where it will be noticed there is no such distinct separation of the proglottis from the next one ahead. So

So far as the writer is aware, this has been pointed out only by Luehe (1910 : 35) when he said: " ... in reifen Gliederstrecken liegen zwischen zwei völlig durchgehenden, aber auch nur wenig hervortretenden oberflächlichen Querfurchen in der Regel 16 sehr kurze Genitalsegmente, die äusserlich voneinander nur durch Zackenbildungen des Seitenrandes geschieden sind." In this connection it should also be noted that in his description of Fimbriaria fasciolaris (Pallas), a taenicid from various water birds, Wolffhügel (1900 : 94) remarked that it is comparable to B. scorpii in that "Eine bis ins aussergewöhnliche gestiegerte Anzahl von Geschlechtsapparaten in einer Proglottis sich folge."

In a considerable length of one toto mount of this form there were found ahead of and including the region of differentiation of the reproductive rudiments the following consecutive number (from behind forwards) of genital segments between the most pronounced transverse furrows, that is in the primary segments in question: 87, 82, 101, 107, 90, 111, 116, -- using as the criterion of a genital segment, especially ahead of the region of differentiation, the aggregation of nuclei in the median line which will go to form the central organs and ducts of the system. But there is much difficulty in making these counts on account of rudimentary or intercalated groups of nuclei which, judging from conditions to be seen in theregion of differentiation, may or may not form complete sets of genitalia, and above all of the further subdivision of many of these rudiments, which otherwise proceeds in quite the same manner (Fig. 48) as that of the external segments in the anterior part of the strobila. Furthermore, there may often be seen either

in the anterior part of the region of differentiation or much farther ahead (Fig. 42) a lateral doubling of the developing genitalia. But since no case was met with of two sets of reproductive organs in a ripe genital segment, it was concluded, especially because of the great infrequency of this duplication, that one or the other rudiment eventually gets the upper hand and develops at the expense of the other. This is borne out by the fact that in half the cases one rudiment was much larger than the other. The above mentioned groups of rudiments were found to be divided and subdivided by less and less pronounced transverse furrows in the following manner:

67		82		101	
43	24	35	47	54	47
24+19	10+14	14+21	18+13+16	16+14+12+12	20+12+15

This continued until eventually the groups of four (or five, rarely six) sets of genitalia of the authors could be made out. But these were seen to be divided into two groups of two sets each, so that each lateral crenulation corresponded to two (or three) of these, i.e., to the 1-32nd division described above (Fig. 32). In ripe segments this arrangement may obtain or the segment may divide again peripherally, so that each crenulation then corresponds with one set of genitalia (Figs. 45 and 46). The latter figures show that "complete" transverse furrows are present between every 8 or 9 (sometimes 7, or apparently even 3, 4, 5 or 6!) genital segments. However, other more relaxed strobilas in alcohol showed complete furrows only every 16 ot 17 sets of genital segments, there often

being a group of 5 instead of the much more common group of four, but in the same neighborhood of the Strobila just as complete grooves every 8, 9 or 10 sets. This shows that a grouping of the genital segments into lots of approximately 16, as mentioned by Luehe (1910 : 33) is not at all regular and can scarcely be said to occur even "as a rule".

The genital sinus is situated on a low papilla (Fig. 47) on the dorsal surface and in the median line from one half to two-thirds of the length of the genital segment from its anterior border, while the uterine opening on the ventral surface is located much farther forward even at the bottom of the groove corresponding to the indentation of the edge of the strobila, separating the crenulations mentioned above. The sinus itself is circular in outline and from 40 to 45μ in diameter by 15 to 20μ in depth. At its bottom the cirrus and vagina open close together, the latter immediately behind the former, thru a secondary sinus or ductus hermaphroditicus, the walls of which are often found protruding thru the opening of the larger vestibule as if to form part of a functional cirrus (Fig. 47).

The testes are arranged in two lateral fiels in the medullary parenchyma, as pointed out by Loennberg, and are continuous from segment to segment, altho they show some tendency towards division interproglottidally. The number was given by Matz (1892 : 106) as about 76, with their size as 40. 8μ , but here it was found to be 30-60, while their size was 35 to 70μ , 60 being the commonest measurement. The vas deferens, filled with sperms, forms a compact mass of coils about 0.18 x 0.10mm. in size, lying

irregularly to the right or left of the uterine duct or slightly behind the sac and immediately alongside the cirrus-sac, as shown in Fig. 48. The ductus ejaculatorius portion of the vas deferens within the cirrus-sac, that is, that part occupying the lowermost one-third of the latter, has a diameter of 4 to 6 μ. The middle stretch of the duct often expands to 13μ, while the distal part, the cirrus proper, has a maximum length of 65μ with a width of 14μ. Matz gave the dimensions of the organ (? the cirrus-sac) as 100 x 50μ. The cuticula lining the cirrus is pseudociliated on its inner (functionally outer) surface, somewhat as is that on the external surface of the worm. The cirrus-sac is located at right angles to the dorsal surface (Fig. 47) and extends only a short distance into the medulla, as compared to other species. It is ovoid in shape, with the narrower end towards the cloaca, and 115-120μ in length by 75-80 in diameter. Its wall is composed of an inner thick layer of circular muscle fibres and a very thin outer layer, the fibres of which are directed somewhat obliquely, the whole being 8 μ in thickness. As pointed out by Loennberg and shown in Fig. 47, the organ is peculiar in that its wall is coated both externally and internally with a thick layer of nuclei which are doubtless mostly myoblastic in their nature. An aggregation of nuclei at the lower pole of the sac, surrounding the vas deferens and continuous with the layer of nuclei on the outside of the pouch, seem to be too numerous to be considered as myoblastic nuclei only. They do not seem to be mentioned either by Loennberg or Matz. Their arrangement would indicate that they are possibly prostatic in their nature, the whole structure having the appearance

of a gland. Retractor muscles of the cirrus proper are scarce. This fact taken in conjunction with the further fact that the wall of the sac is quite thick and powerful and that Loennberg saw only a short thick cirrus when protruded, would lend support to the view that the latter is quite small and not very important from a functional standpoint. Concerning copulation in this species Loennberg said: "Es ist daher wahrscheinlich, dass die normale Befruchtung so vor sich geht, dass das Sperma in den Sinus genitalis hinausgepresst wird, und davon entweder passiv durch die Kontraktion der Sinus genitalis oder aktiv durch eigene Bewegung in die Vagina gelangt. Sowohl die eine als die andere Weise scheint recht möglich zu sein, weil die Mündung der Vagina ganz neben derjenigen des Penis gelegen ist."

The vagina opens into the ductus hermaphroditicus close behind the cirrus, and from that point passes close along the cirrus sac to its lower end, and then turns back to pass over the ovarian isthmus and into the generative space. Its diameter is 13 μ, while its wall is composed of a cuticula 5 μ in thickness and a thin layer of circular muscles. Its cuticula is retained until the point of union with the oviduct is reached, where the lumen narrows down suddenly to one half the former diameter (Fig. 49). The ovary is somewhat irregularly "biscuit-shaped" (Fig. 48) situated close to the posterior border of the segment or protruding slightly into the segment behind. It is composed of short tubular lobules of varying size and has a width of 0.35mm. and a length of 0.15mm. In transsections it is seen to be "concave towards the surface bearing the genital openings" owing to the fact that the ventrally situated

isthmus is quite narrow and thick and consequently not well separated from the lobular rings which extend thruout the whole dorsoventral diameter of the medulla and also somewhat enfold the former posteriorly in the median line. Ova from the isthmus are 15 μ in diameter, while their nuclei and nucleoli average, respectively, 7 and 3μ. The oocapt is quite musculer, and 35μ in diameter. The oviduct proceeds dorsally for a short distance only before it is joined by the vagina at a vestibule into which the oviduct itself opens (Fig. 43) by a narrow slit much as in C. crassiceps. The wall of the duct is composed of an epithelium, in which no cell-boundaries could be made out, but provided with cilia directed towards the uterus. The oviduct continues dorsally for a short distance with the same structure and diameter, namely 18μ, to take on the vitelline duct dorsal to the anterior edge of the isthmus. The vitelline follicles are arranged in the cortical parenchyma in two lateral fields (Fig. 48) which are, however, slightly connected with each other dorsally and ventrally in the median line by a few isolated follicles. No large follicle such as that described by Matz in the neighborhood of the ovary was seen in the material studied. The follicles vary somewhat in size, but average 35 to 55μ in diameter, are very closely crowded together, -- so as to obscure in toto preparations the testes beneath them, -- and continuous from proglottis to proglottis. The latter fact makes it difficult, if not somewhat unnecessary, to state the number for each genital segment, but, using Matz's method of multiplying the average number seen in transections by that seen in Sagittal sections (here the average of several segments was taken), the

number was found to vary from 370 to 540, or 440 on the average. Motz gave 400 as the number. Two main vitelline ducts proceed from opposite sides of the genital segment and unit in the antero-dorsal portion of the generative space to form a very short common duct which from the amount of yolk it usually contains may act as a vitelline reservoir, altho the same function is shared even to a larger degree by the much coiled and distended proximal portions of the separate ducts. A few cases were met with in which small ducts laden with yolk came from follicles clearly belonging to the genital segment following. This condition is, however, not surprising in view of the continuous arrangement of the follicles themselves. The diameter of the common duct at its point of union with the oviduct was found to be about 8 μ. The very voluminous shell-gland is situated dorsal to the ovarian isthmus close behind the cirrus-sac with a depth of 35μ and width of 115μ. The uterine duct is quite capacious since it is composed of may coils extending thruout the whole depth of the medulla immediately ahead of the ovary. Proximally it is lined with a syncitial epithelium which distally becomes much attenuated. While it is usually situated in the median line it may alternate from right to left as a whole according as the vas deferens does so on the opposite side of the proglottis, the uterus-sac in such cases remaining in the median line. As above noted, the uterus-sacs were called "ovaries" by the early writers. They were seen thru the body wall to be filled with the characteristic dark brown eggs forming dark patches or punctations, hence the specific names <u>bipunctata</u> and <u>punctata</u>. In this species the uterus-sacs were described by Rudolphi,

Leuckart (1819 : 41), et al. as arranged in a single row, in a double row, or alternating thruout the strobila. Here they were likewise found to alternate irregularly from side to side (Fig. 46) (e.g., r, l, l, r, r, l, r, l, l, r, r, l, etc.) or to be more medially situated (l., m., l., m., m., m., m., l., m., r., r., m., l., l., m., m., etc.) but never in two rows, excepting in a very few immature genital segments (Fig. 42), unless the alternating condition in much contracted strobilae is considered as such. While the sac has a diameter of about 0.18mm. when the first eggs appear in its lumen, it may reach a length of 0.35mm. and a transverse diameter of 0.32mm. or about one-sixth of that of the proglottis. The combined uterus-sac and uterine duct may in many cases occupy more than one-third of the width of the segment. The hindermost segments, in which the uterus-sacs may be gorged with eggs to a diameter of 0.65mm., separate from the chain evidently in pairs, the lines of division taking place at the furrows between the larger crenulations mentioned above. No detached proglottides were found, however, free in the intestine of the host, altho Olsson (1867 : 55) recorded having found such, while Weinland (1858 : 9) said that, according to Eschricht, the species "which lives in the sculpin of the Baltic (<u>Cottus scorpius</u>) throws off its whole chain of joints every year, and then sends out a new one from the neck". Like that of the distal portion of the uterine duct the wall of the sac is composed of a much attenuated epithelium from the basement membrane of which the nuclei, separated by wide intervals, project into the lumen like bosses. The uterus-opening is situated ventrally in the middle of the uterus-sac, and with regard

to the external segmentation either in the middle of the larger (double) segment or in the groove separating it from the next ahead or behind. Circular in outline and 50 μ in diameter, it is surrounded by an area of radiating nuclei, thought by Loennberg to be possibly of the nature of a gland for the secretion of a material of use in the passage of the eggs to the exterior. The actual opening is formed by the rupture of a membrane guarding the outlet, which has a thickness of from 15 to 30 μ. (Cf. C. crassiceps).

The fresh egg is ellipsoidal in shape, dark brown in color, and measures from 66 to 80 μ in length by 43 to 45 in transverse diameter. The shell was observed to be about 9 μ thick in living material and not provided with an operculum. No mature eggs showing the six hooks of the oncosphere were met with in fresh material in the field.

Nothing was discovered regarding the life-history of this form, not even possible intermediate hosts in the way of food contents, for the stomachs and intestines of the few sea-ravens examined were all found to be empty. Linton (1890 : 733) gave as the food of Lophopsetta maculata and Limanda ferruginea, from which he recorded Dibothrium punctatum Rud., "several species of Annelids, fragments of Squilla, and several specimens of a species of Margarita." No specimens smaller than about 25mm. in length were obtained, so that the appearance of the youngest strobila was not observed. According to Ulinsky's abstract, Pilat (1906 : 181), working on B. scorpii from Raja clavata of the Black Sea (the only case of the species having been found in a selachian fish, so far as the writer is aware) established the fact "dass eine Larven in

den veschiedenen Fischen oder Tieren, welche von Rochen (Raja clavata) gefressen werden, sich befanden."

From the foregoing description it is to be seen that this form is very closely related to the B. scorpii (Mueller) of Europe, altho in many respects it is so different as to almost warrant the erection of a new species to accommodate it. However, on account of the fact that several forms of the European species have been reported, namely, B. scorpii forma bubalidis and forma motellae by Loennberg (1889 : 32 and 1893 : 13) and those from Rhombus maximus and Cottus quadricornis by Schneider (1902a : 14-15 and 1903 : 75-76), it was considered that here in America we have the same species as has been found in Europe. And from a comparison of the measurements given above with those given by Leidy (1855 : 444) and Linton (1890 : 732, 734 and 1897 : 430), it seems that, little as we can rely on external measurements, they also point to definite differences of habit as this worm is found in different host species on this side of the Atlantic.

In the table given below under B. claviceps the important diagnostic data of this form are placed alongside those of the European species for the sake of comparison.

The material studied consisted of lots Nos. 191, 196, 197, 198, 287, and 288 of the writer's collection from the intestine of Hemitripterus americanus (Gmelin), No. 17.57 of the Coll. Univ. Ill. from the same host, and No. 17.56 of the same collection from Myoxocephalus ? aeneus.

Species 2. Bothriocephalus claviceps (Goeze,1782)

(Figs. 50 - 55.)

1722	Vermis multimembris anguillae	Leeuwenhoek	1722 : 490
1780	Taenia anguillae (part.)	Mueller	1780 : 208
1782	Taenia claviceps	Goeze	1782 : 414
1786	Taenia claviceps	Batsch	1786 : 211
1786	Taenia anguillae	Batsch	1786 : 233
1790	Taenia anguillae	Gmelin	1790 : 3078
1790	Taenia claviceps	Schrank	1790 : 46
1800	Rhytelminthus anguillae	Zeder	1800 : 215
1801	Taenia claviceps	Rudolphi	1801 : 103
1802	Taenia anguillae	Bosc	1802 : 307
1803	Rhytis claviceps	Zeder	1803 : 293
1810	Bothriocephalus claviceps	Rudolphi	1810 : 37
1816	Bothrioc. claviceps	Lamarck	1816 : 583
1819	Bothrioc. claviceps	Rudolphi	1819 : 136,472
1819	Bothrioc. claviceps	Leuckart	1819 : 49
1824	Bothrioc. claviceps	Nitzsch	1824 : 97
1844	Bothrioc. claviceps	Bellingham	1844 : 251
1845	Bothrioc. claviceps	Dujardin	1845 : 618
1848	Bothrioc. claviceps	Siebold	1848 : 147
1850	Dibothrium claviceps	Diesing	1850 : 589
1853	Bothrioc. claviceps	Baird	1853 : 89
1854	Dibothrium claviceps	Diesing	1854 : 578
1859	Dibothrium clabiceps	Polonio	1859 : 225
1859	Dibothrium claviceps	Molin	1859 : 8
1863	Dibothrium claviceps	Diesing	1863 : 241
1867	Bothrioc, clavicepp	Olsson	1867 : 56

1885	*Bothrioc. claviceps*	Carus	1885 : 120
1892	*Bothrioc. claviceps*	Matz	1892 : 108
1893	*Bothrioc. claviceps*	Olsson	L893 : 16-17
1896	*Bothrioc. claviceps*	Ariola	1896 : 280
1899	*Bothrioc. claviceps*	Luehe	1899 : 43
1900	*Bothrioc. Claviceps*	Ariola	1900 : 393
1902	*Bothrioc. claviceps*	Fuhrmann	1902 : 441,447
1910	*Bothrioc. claviceps*	Luehe	1910 : 25

Specific diagnosis: With the characters of the genus. Large cestodes up tp 540mm. long by 2-3 wide. Scolex small,elongate, but usually found contracted to an almost spherical shape; 0.6-1.5 mm. long by 0.3-0.5 wide at the middle. Prominent terminal disc. First segments thick. short and crowded; middle,oblong; posterior, or ripe proglottides,usually 2mm. broad by 0.5-0.7 long, often quadrate. arranged in groups of two, between which the transverse furrow is not prominent. Other transverse furrows well marked.

Cuticula 1-2 μ thick. Calcareous bodies very scarce. Main longitudibal muscles not in bundles. 4-6 chief longitudinal excretory vessels.

No genital papilla; genital cloaca funnel-shaped, midway between anterior and posterior borders of the proglottis. Vagina opens immediately behind the cirrus-sac; no separation bettween common cloaca and hermaphroditic duct.

Testes large, subspherical, averaging 58μ long, 64μ wide and 60 deep; 50 to 60 for each proglottis. Coils of vas deferens loose, close behind uterus-sac, 0.35mm. wide by 0.07 long. Cirrus-pouch ellipsoidal, 127-145 deep by 81-104 in diameter,thin-walled.

Ovary compact, 0.45-0.55mm. in width, 0.055 in length by 0.18

in depth; isthmus quite thick, ventral. Oocapt 30μ in diameter. Vitelline follicles not separated into two fields on either surface, 450 to 720 in number, 45, 80, and 85μ in length, width and depth, respectively; vitelline reservoir large, 175 x 65μ. Shell-gland posterodorsal, alternating irregularly from right to left opposite the vas deferens. Uterine duct quite voluminous, between ovary and uterus-sac. Uterus-sac transversely elongate, occupying one third or more of the transverse diameter of the proglottis, usually larger towards the side bearing the opening; openings form a zig-zag ventral row.

Egg, 58-63μ long by 37-40 wide, without opercula; light in color, show only faintly thru the body-wall.

Habitat: In the pyloric portion of the intestine of the host.

Host	Locality	Collector	Authority
<u>Anguilla</u> <u>vulgaris</u>	----------	Leeuwenhoek	Diesing 1850 :590
" "	----------	Zeder	" " "
" "	Rennes	Dujardin	Dujardin 1845:618
" "	Patavia	Molin	Diesing 1863:241
" "	Onegasee, Russian Finland	Kessler	Schneider 1902:17
" "	Sinus Codani	Olsson	Olsson 1 1867:56
" "	L.Halland, Sweden	"	" " "
" "	Venice	Ninni	Stossich 1891:8
" "	Ostsee, Warnemünde and Unterwarnow-Rostock	Braun	Braun 1891:55

Anguilla vulgaris	------------	-----------	Matz	1892:109
" "	Genova	Parona	Ariola	1900:394
? " "	Nancy	Prenant	Zschokke	1896:818
? " "	Königsberg & Memel	Muehling	Muehling	1898:35
" "	Peninsula of Porkala, Finland	Schneider	Schneider	1902:15
" "	Lake Garda, Italy	Largaiclli	Ariola	1900:394
" acutirostris	Ireland	Bellingham	Bellingham	1844:251
" "	------------	Siebold, Coll. Brit. Mus.	Baird	1853:90
Anguilla anguilla	Germany	------------	Luehe	1910:25
" migratoria	------------	Kroyer	Stiles & Hassall	1912:124
Muraena anguilla	------------	Borke	Goeze	1782:414
" "	Gryphswald	Rudolphi	Rudolphi	1810:38
" "	------------	Kais.-konig.-nat'lkab	Leuckart	1819:49
" "	Hjorja, Scania, Sweden	Olsson	Olsson	1893:16
" "	Lakes Hälen & Defundsjön, Jemtland, Sweden	"	"	" "
" "	Bönan, Gulf of Bothnia	"	"	" "
" cassini	Naples	Rudolphi	Rudolphi	1819:472
Anguilla rostrata	Chamcook L., New Brunswick	Cooper	Cooper (the present paper)	
Eupomotis gibbosus	Walnut L., Mich.	H.B.Ward	"	
Gandsnosteus bispi-	Woods Hole, Mass.	V.N.Edwards	"	

Since the earlier writers dealt merely with the external features of the species, their descriptions are of little comparative value when the finer distinctions are at stake. In late years Ariòla (1896 : 280; 1900 : 393), Luehe (1899 : 43), Braun (1900 : 1676) and Fuhrmann (1902 : 441, 447) dealt with it from a systematic standpoint, and finally Luehe (1810 : 35) gave a short diagnosis, in placing it in his latest classification of the group; but all referred back to the original and evidently only adequate description of the internally anatomy, namely, that by Matz (1892 : 108-110). Here will be given only the most important specific data of value for a comparison of the form studied with the description by the latter writer, since the accompanying figures illustrate many of the details sufficiently.

In the material from Eupomotis gibbosus all of the anterior proglottides were found to be much boader than long, on account of the contraction of the strobilas, while those in detached pieces were from four to five times as broad as long, as shown in Fig. 54. Apart from Matz, Olsson (1893 : 16) and Luehe (1910 : 25) have noted secondary division of segments, while Dujardin (1845) originally said that "On remarque en outre que souvent les articles sont tellement unis deux à deux, que chaque couple paraît n'en faire qu'un seul avec une ride transverse et deux appareils génitaux l'un devant l'autre." This pairing of the ripe proglottides (Fig. 54) is due to the manner of segmentation which was found to be like that described for B. scorpii, only quite regular since the reproductive rudiments appear relatively farther forward in the strobila and seem to be more stable in development. Concerning

the arrangement of segments for this species Luehe (1910 : 25) said that, "Zwei aufeinanderfolgende Genitalsegmente äusserlich häufig nur vollkommen geschieden, indessen fehlen durchgehende Querfurchen auf den Flächen nie auf so weite strecken wie bei B. punctatus." On account of the great degree of contraction of the strobila at hand, provided with scolices, the primary sdgments were not followed with entire satisfaction very far beyond the scolex, but the first two were seen to be divided into four sub-segments each, -- the first one, shown in Fig. 50, including the four segments to the (*) at the side of the figure, -- with some indication of the next division which would result in eight seg ments to the primary segment; the third into eight, and so on. There were indications posteriorly, however, that the primary segment consists of at least 32 genital segments or proglottides, but as in B. scorpii the furrows separating sets of 16, 8, and 4 genitalia become almost as prominent as those between the groups of 32, while even those separating pairs are not as faint as Olsson (1893 : 16) stated and showed in his Fig. 1, Tab. II. At all events it should be emphasized that the furrows are more distinct and consequently the proglottides better defined, at least externally, than in B. scorpii.

The following table gives the measurements of three of the largest specimens studied:

Number	17.33.1	17.33.2	17.54.1
Length of scolex	0.44mm.	0.46mm.	0.46mm.
Breadth of terminal disc	0.22	0.20	0.22
" at middle	0.28	0.30	0.33
Depth of terminal disc	0.20	0.20	0.20
" at middle	0.26	0.20	0.40
" posteriorly	0.27	0.27	0.46
Length of strobila	155	150	43
Maximum breadth	2.9	2.9	2.0
Width of ripe segments	2.0	2.0	1.6
Length of " "	4.0-5.0	4.0-5.0	0.4-0.6

Up to the time when Diesing (1863 : 241) incorrectly described the genital apertures as marginal and alternating, the only references to the reproductive organs of this species were to the uterus-sacs which were visible as faint punctations in the median line. Carus (1885 : 120) failed to correct Diesing's error, so that it remained for Matz (1892 : 109) to give the first description of the genitalia, upon which we can rely, in which, however, only the differences between them and those of B.scorpii were emphasized. The earliest traces of the reproductive rudiments were seen by the writer about 5mm. from the tip of the scolex while the first eggs in the uterus-sacs came at about 55mm. While the opening of the uterus is well towards the anterior edge of the segment, that of the genital cloaca is midway between the anterior and posterior borders. There is no papilla, the opening being a low funnel-shaped depression in which there is no

division into an external common cloaca and an hermaphroditic duct (Fig. 55). The important data concerning the rest of the reproductive organs are contained in the following table, where only those of comparative value are given:

	B.scorpii		B.claviceps	
	European data	Data by writer	European data	By writer
Length.........	35-600mm.	677mm.	90-540mm.	155mm.
Breadth........	1-7	3.35	2-3	2.9
Length of scolex	0.9-3.0	1.2	0.5-1.5	0.46
Breadth " "	0.3-1.7	0.35	0.5	0.30
Breadth of posterior segments	4.0	1.8	2	2.0
Length of same..	0.22	0.35-0.85	0.5-0.75	0.5
Number of genital segments per external segment	16	8 or 16	Less than in B.scorpii	See text
Number of longitudinal excretory vessels	6,8,12	6	4	6
Number of testes	76	30-60	56	50-60
Diameter of same	40.8	35-70	36-47	60-70
Dimensions of cirrus-sac	100 x50	120 x 80	109 x 64	145 x 109
Number of vitelline follicles	490	350-540	462	450-720
Size of same	30-40	35-55	-------	-------
Arrangement of same	In 2 separate dorsal fields; 2 ventral fields weakly united	Dorsal fields slightly united; 2 ventral fields weakly united	Dorsal fields united; ventral fields weakly united	Dorsal united; ventrals united to same degree
Dimensions of eggs	50-80 x 40	66-80 x 43-45	50-60	58-63 x 37-40
Arrangement of uteri	1 row, alternating, or 2 rows	1 row, alternating, or 2 rows	-------	--------

Diameter uterus : diam. segment	Only small portion of diameter	1 : 6	1:3 - 1:2	1 : 3
Longitudinal muscles	"Close together"	In bundles	Not in bundles	Not in bundles

From the above comparison it will be seen that altho the individuals from Eupomotis gibbosus (those from which the data were taken) do not exactly agree with the European species, they are sufficiently close to justify their being considered the same. And this was made more certain to the writer by the esamination of some fragments of the European form, obtained by Professor Ward from Dr. O. Fuhrmann of Neûchatel, Switzerland, who took them from Anguilla vulgaris in "North Germany". But it should be stated that in the latter material the cirrus-sac and ovary are smaller and the uterus-sac much larger, occupying more than half the diameter of the proglottis in many places; or the reproductive organs seem to become mature relatively earlier, differences in degree of contraction and relaxation being taken into consideration.

The material studied consisted of No. 289 of the writer's collection from Anguilla rostrata, Nos. 17.33 and 16.456 from coll. Univ. Ill., the former from Eupomotis gibbosus and the latter from Anguilla vulgaris (North Germany), and No. 17.54 of the same collection from Gasterosteus bicepinosus.

Species 3. Bothriocephalus Caspidatus spec.nov.
(Figs. 56 - 63)

Specific diagnosis: With the characters of the genus. Medium sized cestodes up to 180mm. in length by 2.75 in breadth. Scolex large with very prominent terminal disc deeply notched surficially; bothria long and narrow and quite deep posteriorly giving the scolex when viewed laterally the appearance of an arrowhead; 3.3mm. long, 1.0 wide at middle 2.5 deep posteriorly. First

segments subcuneate and circular in transection, with prominent posterior borders; middle gradually broaden until much wider than long; posterior two to four and a half times wider than long or 1-2.7mm. in width by 0.8 in length. Posterior end of strobila usually rounded, even when segments have already become detached.

Cuticula 3.5 μ thick, subcuticula 58 μ . No calcareous bodies. Longitudinal muscles not in bundles. Four main longitudinal excretory vessels.

Genital cloaca median, halfway between anterior and posterior borders of proglottis, deep and funnel-shaped. Vaginal opening close behind that of cirrus; hermphroditic duct-obscure.

Testes on each side separated into two fields by nerve strand, inner much narrowed than outer; 50 to 60 in each proglottis; 110,60 and 80 μ in maximum width, length and depth, respectively. Vas deferens a large compact mass of coils, elongate and laterial to cirrus-pouch, 0.32mm. long by 0.16 in width, alternates irregularly from right to left. Cirrus-sac very large and thin-walled, 0.25 mm. in length (depth) by about 0.20 in diameter. Cirrus protruded, 135 μ long by 85 in diameter.

Ovary compact, with limbs often turned forward, 0.60mm. wide, 0.10 long and 0.13 thick; isthmus thick. Oocapt 25-30 μ in diameter. Vitelline follicles 800 to 1000; 70,50 and 45 μ in maximum depth, width and length, respectively; occupying almost the whole of the cortex, strongly united dorsally and ventrally. Common vitelline duct long and narrow. Uterine duct confined to one side of the median line, opposite the cirrus-sac, alternating irregularly from side to side. Uterus-sac spherical, occupying one-

third of the diameter of the proglottis; opening median, close to the anterior edge of the latter.

Eggs ellipsoidal 63-66μ long by 42-45 wide, oncospheres not devdloped within uteri.

Habitat: Caeca and intestine of the host.

Host	Locality	Collector	Authority
Stizostedion vitreum (type host)	Flat Rock L., Muskoka Dt., Ont.	Cooper	Cooper (the present paper)
" "	Giant's Tomb Id., Georgian Bay	"	"
" "	Sandusky, Ohio.	H.J.VanCleave	"
" "	New Baltimore, Mich.	H.B.Ward	"
" "	Port Clinton, Ohio	"	"
" "	Put-in Bay, Ohio	"	"
Stizostedion canadense	New Baltimore, Mich.	"	"
" "	Kansas City, Mo.	H.M.Benedict	"
Hiodon tergisus	Havana, Ill.	H.J.VanCleave	"
" alosoides	Keokuk, Iowa	H.B.Ward	"

Type specimen : No. 174.2 of the writer's collection.

Co-type : No. 174.3 of the same collection, deposited in the Collection of the University of Illinois under the direction of Professor Henry B. Ward.

Type locality : Georgian Bay, Lake Huron, off Giant's Tomb Island.

So far as the writer has been able to ascertain a description of this species has not yet been published, nor have any bothriacephalid cestodes been reported from the hosts listed above. The specific name cuspidatus, here chosen, has reference to the peculiar shape of the scolex as seen from the side : cuspis, an arrow-head.

The first segments of this species show subdivision according to the same plan as that described for B. scorpii. Each primary segment was seen to be divided into two segments of the second order (Fig. 56) and farther back these again into segments of the third order, and so on, until, when the rudiments of the reproductive organs appear, the primary segment, whose boundaries can be recognized by carefully following along backwards from the scolex, contains 32 of them. This plan can be followed well into the region of differantiation. There is not nearly so much irregularity, introduced by intercalated segments and the subdivision of others, as in B. scorpii, altho the same sort of dominance of the anterior ends of the major divisions over their posterior ends is seen not only in the size of the subdivisions and that of the reproductive rudiments but, in the beginning of the region of differentiation, in the rate of differentiation of the common rudiment into the different proximal organs of reproduction. The latter is indicated in good toto preparations as well as in sections. As soon, however, as the lumina of the uterus sacs appear the plan becomes obscured by the gradual enlargement of the posterior borders of the subsegments even to those of the fifth order; so that in turn we can see defined, as we follow them posteriorly, groups of

32, 16, 8, 4, 2 sets of genitalia (Fig. 60). Andveventually at the posterior end of medium sized strobilas and for considerable stretches of the largest, these pairs become separated, and the segment contains only one set of genitalia.

No statements can be made by the writer concerning the intermediate stages of the life history of this species. It may be said, however, that many of the earliest formed segments are lost long before they become sexually mature, since most of the youngest strobilas are found lacking the end proglottis. Constrictions at about the middle were present in many of them, as if the length of segments behind that region might be thrown off as a whole; but, since this was not a constant feature, it was considered to be due rather to the fixation of a wave of contraction passing over the strobila, such as may be seen in living individuals as well as in plerocercoids of other species of cestodes, e.g. Scolex polymorphus.

The material studied consisted of 24 lots from the collections of the University of Illinois (Professor H. B. Ward), of Dr.H. J. Van Cleave and of the writer, from the hosts as above listed.

Species 4. Bothriocephalus manubriformis (Linton, 1889)

(Figs. 64-70)

1889	Dibothrium manubriforme	Linton	1889 : 456
1890	Dibothrium manubriforme	"	1890 : 758
1897	Dibothrium manubriforme	"	1897 : 429
1900	Bothriocephalus manubriformis	Ariola	1900 : 410
1902	Bothriocephalus manubriformis	Porona	1902 : 7

Specific diagnosis: With the characters of the genus. Large cestodes up to 220mm. in length by 5mm. in maximum breadth. Scolex large, elongate, with prominent terminal disc deeply notched laterally as well as surficially, constricted posteriorly; length 2-3.5mm., depth at middle, 1.0, breadth of disc, 1.0. Bothria long and very narrow posteriorly where the walls are quite thick. First segments cuneate with salient posterior borders which are distinctly emarginate; middle, broadly cuneate, less emarginate; posterior or mature many times broader than long and closely crowded, 5 x 0.2mm.; gravid proglottides, 2 x 0.4mm. Posterior half to two-thirds of the strobila provided with a median line (the combined uterus-sacs).

Cuticula 4.5μ thick. Calcareous bodies large, 18-36 x 11-15μ . Longitudinal muscles well developed, in bundles. Anteriorly 4 chief excretory vessels.

Genital cloaca median or slightly displaced towards either side, deep and narrow, separated from the hermaphroditic duct by a narrow muscular velum, half way between anterior and posterior

borders of the proglottis. Vagina opens immediately behind cirrus or very slightly to one side.

Testes ellipsoidal in shape, 64-75 μ wide, 45-60 long, 64-80 deep; 60 to 70 in number, dorsal in the medulla. Vas deferens closely applied to inner end of cirrus pouch, 85μ long, 175 wide and 400 thick, somewhat crescentric in the dorsoventral-transverse plane, opposite the uterus-sac. Cirrus-sac long and cylindrical, 0.50 x 0.14mm., inner half deflected towards the vas deferens, walls very thick, composed mostly of circular muscles. Cirrus short, usually not extending outside of the proglottis, 30 to 35μ in diameter.

Vagina with bulbous sphincter near its opening, 50μ long by 70 in diameter. Ovary irregularly branched but compressed anteroposteriorly, 0.45mm. wide; isthmus only ventral. Oocapt 30μ in diameter. Vitelline follicles extremely numerous, 35μ long, 60 wide and 85 thick. Vitelline reservoir large, 60μ in diameter. Uterine duct voluminous on both sides of the median line, crowding all other organs. Uterus-sacs alternate irregularly from side to side, each 0.45mm. in diameter, encroach greatly on neighboring segments, with thick musculo-glandular funnel-shaped ventral portion. Apertures form two lines on the ventral surface 1mm. apart.

Eggs 58 x 34 μ, dark brown showing thru walls of uterus-sacs.

Habitat : Intestine of the host.

Host	Locality	Collector	Authority
Tetrapterus albidus (type host)	Woods Hole, Mass.	Linton	Linton, 1889 : 458
Histiophorus gladius	Newport, R.I.	"	" 1890 : 731
Istiophorus nigricans (= H. gladius)	WoodsHole	"	" 1901 : 448
Tetrapterus imperator (= T. albidus)	"	"	" " : 447
Tetrapterus belone	Portoferrajo, Id. Elba	Damiani	Parona 1902 : 7

Type specimen : No. 4711, Coll. U.S.Nat.Mus.
Co-type : No. 16.461, Coll. Univ, Ill.
Type locality : "Penekese?"

As regards the segments of this species Linton (1889 : 456) stated that, "Immediately back of the head the segments are very narrow, and for a greater or less distance, depending on the state of contraction, maintain about the same width as the base of the head. In some individuals the small anterior segments continue much farther back from the head than in the one figured. The segments are alternately short and long. This characteristic is quite plainly marked in those segments which immediately follow the head, is still noticeable on the median segments and also on the posterior ones, but is not so plainly marked on the latter as on the two former." This is due to the plan of subdivision of the segments, which is quite like that described for the preceding species. It can be followed with certainty, however, only in the "anterior" and "median" portions of the strobila and not posteriorly where the segments are very short and crowded close toge-

ther longitudinally even tho the latter may not show the rudiments of the reproductive organs. Fig. 66 is of a primary segment (the fifth from the scolex in this case) to show this method of segmentation. Here there is a marked dominance of the anterior over the posterior half of the segment as regards the rate of division; and this is seen to be also quite applicable to the subsegments even to those of the fourth order. "In one specimen examined," to continue quoting from Linton, "the first six segments did not show this alternation in size. In the next fourteen segments, however, the alternation was quite evident." This indicates that he was well acquainted with the division of the segments into subsegments, but did not hit upon the exact manner in which it is carried out.

As regards internal segmentation the writer found that, apart from the sets of genitalia, the musculature in general, -- and for that matter the arrangement of the vitelline and the testes, -- bear out Linton's (1890 : 731) conclusion that, "So far as any internal characters go, the body is practically continuous."

Nothing is known of the life- history of this species.

The material studied consisted of two lots: No. 4711, U.S. N.M., from the rectum of <u>Tetrapterus</u> sp. from "Penekese?" determined by Linton, and No. 16.461, Coll. Univ. Ill. (H. B. Ward) from the intestine of <u>Histiophorus gladius</u>, obtained from Professor Linton and evidently the actual specimen described by him in 1896. The species was determined and the above diagnosis prepared from confirmatory sections of the latter.

Dibothrium laciniatum Linton

Linton (1897 : 425) established this species on the basis of the material contained in lot No. 4741 of the collection of the United States National Museum from Tarpon atlanticus, the Tarpum, and again reported it from the same host species in 1901 (p. 437). Luehe (1899 : 43) in his list of the species of the genus Bothriocephalus s.str. remarked that "Von weniger gut bekannten Arten gehören anscheinend noch hierher Bothriocephalus laciniatus (Lint.) und occidentalis (Lint.)"; while Ariola (1900 : 414) also placed it in the same genus as he conceived it to be constituted.

During the study of B. manubriformis the writer was impressed with the great resemblance between D. laciniatum and it, in all but a few details the two being, in fact, identical. The measurements for length and maximum breadth, as shown in the comparative table below, agree, while those of the scolex and anterior segments are as near as can be expected from cestode material which is found in various degrees of contraction and relaxation. All of the conditions represented in Linton's (1897) Figs. 7-12, Pl. XXX, were observed in the material of B. manubriformis studied, -- when such obvious errors as, "Fossettes marginal as to head, corresponding to the flat surface of body," are taken into consideration, -- while the description of the external features, excepting that of the posterior segments, applied in detail. But later lot No. 4741, U.S.N.M., was obtained by Professor Ward, and the writer learned that his suspicions were well founded; for D. laciniatum proved to be identical with B. manubriformis. The posterior segments "with

breadth one and a half times the length" had different proportions from those observed in mature material of the latter species, because they were, altho gravid, of quite younger strobilas. The material of No. 4741 is, in fact, intermediate between No. 4741 of B. manubriformis and the 16.461 of the same species studied by the writer, not so much in size, since it does not show the regions so well, as in degree of maturity. The fact that "the segments are not uniform; one segment with a salient posterior border followed by about two with less salient borders is due to the irregular manner in which the primary segment divides into subsegments (vide supra). The dimensions of theeggs correspond, while the measurements of the cirrus-bulb, vaginal sphincter, and calcareous bodies are the same in the two species: Linton stated that in D. laciniatum "The reproductive cloacae lie along the medinn line of one of the flat surfaces of the body. The external openings of the uterus lie along the median line of the opposite surface." While the former was found to be the case, the latter was not, for the openings of the uteri lie irregularly on either side of the median line as in B. manubriformis. Furthermore the cirrus-bulb was not found to have "its inner end deflected to the right (left, when we take into consideration the fact that the common genital cloaca of D. laciniatum was considered to open on the ventral instead of the dorsal suface) where it communicates with the vas deferens, which lies in numerous folds in front and to the right of the cirrus-bulb," but to alternate irregularly from side to side according as the uterus-sac and distal end of the uterine duct occupy the other side of the proglottis, while the vas deferens is

as given above. Altho the vaginal bulb was found to be a little larger in the material of D. laciniatum, its structure and position were also quite as in B. manubriformis. On the other hand no muscle fibres completely encircling both genital apertures, such as shown in Linton's Fig. 5, Pl. XXXI, were seen, but what might easily be taken for such were formed by the crossing of much curved and spread longitudinal and transverse fibres of the body wall, in such a manner that the portions intersecting at the four corners run in almost circular directions and concentrically parallel to each other so as to give the appearance of the whole forming a complete ring in each case. The genital cloaca was found to be shallower than in the material from Histiophorus gladius, which is evidently due to the fact that the proglottides were younger and not yet gravid as in those from the latter host. The uterus-opening was not found to be "lined with cilia" but with irregular rugged processes which are evidently only portions of the lining of the developing funnel and the external duct of the same. Finally the position and structure of the ovary, of the vitelline reservoir and of the various layers of the body exactly correspond in the two forms.

Consequently the writer feels that there can be no doubt whatever concerning the identity of D. laciniatum with B. manubriformis, which fact would also seem to be recognized in the Fauna of the Woods Hole Region (Sumner, Osborn and Cole, 1913 : 585) where the former is not found among the cestodes, altho the host, Tarpon atlanticus, is listed, and since B. manubriformis was described before D. laciniatum, the latter must be considered as a species delenda.

B. histiophorus Shipley

The writer would also like to call attention in this place to the fact that Shipley's (1901) Bothriocephalus histiophorus agrees in all essentials with B. manubriformis, which is almost to be expected since both are found in the same host genus.

The description and figure of the scolex is that of the latter species, altho the true nature of the bothria was not ascertained by Shipley on account of their almost closed condition, which was also seen in many specimens of B. manubriformis by the writer. Consequently it was described, obviously erroneously, as " ... provided with longitudinal slit-like depressions which hardly attain the dignity of suckers situated in the dorsal and ventral plane." The external features of the strobila are the same in both species, altho Shipley was describing a comparatively young specimen, as shown in his measurements of the scolex and in his figures showing the size of the uterus-sac. The description and figures of the genitalia agree in almost all details. It is quite apparent, however, that his Fig. V, diagrammatic it is true, is entirely misleading as to the proximal connections of the reproductive ducts, one of which, the ootype, be confused with the isthmus of the ovary. The ova in the latter were also found by the writer to be 15 μ in diameter in B. manubriformis as in B. histiophorus. Besides, his description of these central connections of the genital ducts is certainly not that of the genus Bothriocephalus, for in dealing with the isthmus of the ovary, which he called the ootype, he said that "Into this region opens the small shell-gland,

and the ducts of the yolk glands. The shell-gland lies posteriorly to the ovary between the right and left halves of that organ and with the ducts of the yolk glands it opens into the ootype posteriorly"! The measurements of the eggs and the description of the uterus agree with those of Linton's species, excepting that the opening of the uterus-sac " ... does not seem to be provided with anything of the nature of a sphincter muscle...." Altho the material at hand did not permit of the sectioning of such young stages in the development of the uterus-sac, it would seem from the somewhat varying nature of its funnel-shaped ventral end, described above for B. manubriformis, that in more anterior proglottides it might be in such a condition as to be easily overlooked. Here Shipley makes a statement concerning the probable disposal of ripe eggs, which seems to the writer to be the natural conclusion to arrive at after a study of the varying contents of the uterus-sacs along the strobila, namely, "From what I have seen I think it probable that eggs pass out from the tapeworm into the alimentary canal of the host and that in B. histiophorus the eggs pass freely out from each ripe proglottis and do not wait until the posterior proglottides break off to make their escape from the parent." The nature and arrangement of the vitelline glands, the vagina and its bulb or sphincter, the testes in number and position, and finally the cirrus-sac, all considered in connection with his Figs. I-IV, force the writer to the conclusion that, so far as can be determined in the absence of material for study, Shipley's B. histiophorus n.sp. is identical with B. manubriformis (Linton).

In the following table a number of important measurements

of *B. manubriformis*, *D. laciniatum* and *B. histiophorus* are given for the sake of comparison.

	D.laciniatum	B.histiophorus	D.manubriformis
Maximum length of strobila	154 mm.	------	220 mm.
Maximum breadth of strobila	4	-------	5
Breadth at posterior end	2	-------	2
Length of scolex	2	--1.8--	1.5-3.5
Breadth of terminal disc	0/8	0.4	0.8-1.2
Breadth of scolex at middle	0.4	-------	0.64
Breadth at posterior end	0.6	-------	0.81
Breadth at constriction	0.25	-------	0.21-0.44
Depth of terminal disc	0.5	-------	0.89
Depth of scolex,middle	0.55	-------	0.90-1.05
Depth at posterior end	0.35	-------	0.63
Depth at constriction	0.25	-------	0.58
Length first segment	0.7	-------	0.39
Breadth same anteriorly	0.3	-------	0.28-0.54
Breadth same posteriorly	0.65	--------	0.50-0.89
Length of median seg'ts	0.3	0.3	---------
Breadthof median seg'ts	0.3	--------	---------
Length posterior seg'ts	1	0.16("ripe")	1.0
Breadth of same	1.5	0.5 ("ripe")	2.50
Length of cirrus-sac	0.4	--------	0.50
Max.diameter of same	0/14	--------	0.14

Length of vaginal sphincter	0.05	--------	0.05
Diameter of same	0.07	--------	0.07
Dimensions of eggs	52 x 35	45 x 35	58 x 34
Dimensions of calcareous bodies	17-24 x 8-14	--------	18-26 x 11-15
Number of testes	--------	50 - 70	60 - 70
Diameter of ova in ovarian isthmus	--------	0.15	0.15

Species 5. Bothriocephalus occidentalis (Linton, 1897)

(Figs. 71 and 72)

1897	Dibothrium occidentale	Linton	1897b : 437
1899	Bothriocephalus occidentalis	Luehe	1899c : 43
1900	Bothriocephalus occidentalis	Ariola	1900b : 415

Specific diagnosis: With the characters of the genus. Large cestodes with maximum length of at least 310mm. and breadth 5.5. Scolex small, elongate and somewhat rectangular, constricted posteriorly, 1.3mm. long by 0.46 wide. First segments somewhat funnel-shaped; middle, densely crowded, ten to twenty times broader than long, posterior narrower and longer, 2 x 0.8mm., in groups of three or four.

Cuticula 1.5 μ in thickness. Calcareous bodies 18 x 13 μ. Longitudinal muscles in bundles, outer series very scarce. Four chief excretory vessels, two much more prominent than the others.

Genital cloacae form a nrrow zig-zag row, each very shallow, no velum, cloaca and hermaphroditic duct united. Vagina opens directly behind cirrus or a little to one side.

Testes divided into two fiels on each side by the nerve strand, 75 to 90 in number, 25, 85, and 115 μ in average maximum length, breadth and depth. Coils of vas deferens loosely arranged, the duct 25 μ in diameter, alternating irregularly from side to side opposite the uterus-sac. Cirrus-sac long and cylindrical, 0.23 x 0.06mm., walls comparatively thin, most of circular muscles being towards the inner end.

No vaginal sphincter or bulb. Ovary solid, unbranched, 0.5-0.6mm. wide, 0.04 long and 0.13-0.18 deep. Oocapt 25 μ in diameter. Vitelline follicles very numerous, in two lateral fields on each surface, leaving a broad median strip free, 25, 60, and 115 μ in length, breadth and depth, respectively. Vitelline reservoir 45 μ in diameter. Uterine duct voluminous on both sides of the median line, crowding all other organs. Maximum width and length of uterus-sac, 0.65 and 0.25mm., respectively; not encroaching much on neighboring proglottids; ventral portion not especially modified, Uterus-openings alternate irregularly from side to side near the median line, for forward in the proglottides.

Eggs 72-76 x 38-41 μ , dark brown, showing thru the walls of the gorged uterus-sacs.

Habitat: Intestine and pyloric coeca of the "rock cod", Sebastodes sp?

Type specimen : No.4740, U.S.N.M., collected by T. H. Bean and identified by Professor Edwin Linton.

Type locality: Whatcomb, Washington.

The material contained in No. 4740, U.S.N.M., upon which Linton based the species, was examined by the writer and confirmatory sections made of mature segments, but it was all in such a very poor state of presevvation that much of the detail could not be made out. However, as the specific diagnosis indicates, this is a true species of the genus Bothriocephalus s.str. and quite distinct from B. manubriformis which it closely resembles in many respects, internally as well as externally. So far as the writer

is aware it is the only bothriocephalid that has been reported for the Pacific coast of America, the fauna of which in this connection has thus only been touched.

Genus 2. Clestobothrium Luehe, 1899.

Bothriocephalus (part.)	Rudolphi,	1819.
Dibothrius (part.)	Rudolphi,	1819.
Bothriocephalus (part.)	Leuckart,	1819.
Bothriocephalus (part.)	Dujardin,	1845.
Dibothrium (part.)	Diesing,	1850,
Dibothrium (part.)	Molin,	1858.
Dibothrium (part.)	Diesing,	1863.
Bothriocephalus (part.)	Carus,	1885.
Bothriocephalus (part.)	Ariola,	1896.
Clestobothrium	Luehe,	1899.
Bothriocephalus (part.)	Ariola,	1900.
Clestobothrium	Braun,	1900.

Generic diagnosis: Scolex almost spherical, the free edges of the dorsoventrally situated bothria fused with each other in their whole extent, in such a manner that only a small surficial opening near the apex leads into the interior of the spacious, hollow organ of attachment, flattened in the sagittal direction, by means of a short almost sagittally coursing canal which can be closed by a sphincter-like musculature. External segmentation complete. Vitelline follicles in the cortical parenchyma. Ovary median and ventral. Receptaculum seminis small. Beginning of the uterus a winding canal which leads into an extraordinarily spacious uterus-sac, distorting all the other genital organs in ripe

proglottides. Uterine opening about median as is the dorsal genital opening.

Type species: C. crassiceps (Rudolphi).

Clestobothrium crassiceps (Rudolphi,1819)
(Figs. 73-83.)

1819	Bothriocephalus crassiceps	Rudolphi	1819 : 139,476
1820	Bothriocephalus pilula	Leuckart	1819 : 45-46
1845	Bothriocephalus crassiceps	Dujardin	1845 : 617
1850	Dibothrium crassiceps	Diesing	1850 : 587
1858	Dibothrium crassiceps	Molin	1858 : 134
1863	Dibothrium crassiceps	Diesing	1863 : 2 36
1885	Bothriocephalus crassiceps	Carus	1885 : 120
1896	Bothriocephalus crassiceps	Ariola	1896 : 280
1899	Clestobothrium crassiceps	Luehe	1899 : 44
1900	Bothriocephalus crassiceps	Ariola	1900 : 397
1900	Clestobothrium crassiceps	Braun	1900 : 1692
1901	Dibothrium crassiceps	Linton	1901 : 411,451 473
1909	Dibothrium crassiceps	Johnstone	1909 : 87-89

Specific diagnosis: With the characters of the genus. Medium sized cestodes, up to 92mm. in length, with a maximum breadth of 1.5mm. Anteriorly surface of body with closely arranged transverse furrows, posteriorly segmentation more distinct, serrate. Scolex globose, 0.64-1.08mm. long, 0.52-0.90 broad,and0.68-1.21 thick; divided by longitudinal marginal grooves into two dorsoventral

hemispheres, the bothria. Latter, large, prominent, oval, their apertures about one-third from the apex and connected by a saddle-shaped groove over the tip of the scolex, with prominent lips. No neck, segmentation beginning immediately behind the scolex. Young segments closely arranged, five to six times as broad as long; mature proglottides quadrate to twice as long as broad, frequently divided on one or both sides by spurious articulations usually behind the uterus-sacs.

Cuticula 2 to 5μ thick, subcuticula 20. Chalk-Bodies absent. Musculature well developed, powerful sphincter around orifice of bothrium. Chief nerve strands ventral, 15 to 20μ in diameter. Usually four longitudinal excretory vessels.

Genital cloaca median, dorsal, three-fourths to one-half the length of the proglottis from its anterior end, usually just posterior to the spurious articulations; hermaphroditic duct within this.

Testes in two lateral fields in the medulla; ellipsoidal in shape, 0.125mm. long by 0.04 in diameter, continuous from joint to joint, 40 to 50 to each proglottis. Vas deferens forms a wedge-shaped mass of coils ahead of cirrus-sac and alongside of the hinder end of the uterus-sac. Cirrus-sac elliptical to somewhat oval, 0.128-0.162mm. long by 0.087-0.116 wide and 0.098-0.116 deep, immediately behind the uterus-sac or lateral to its posterior end. Cirrus-sac and vas deferens together alternate irregularly from right to left opposite the hinder end of the uterus-sac.

Opening of vagina close behind that of cirrus. Receptaculum seminis present as a short diverticulum almost parallel to the oviduct at the point of union of the vagina with the latter, about 10μ in diameter. Ovary bilobed, the isthmus narrow and ventral, ova in same 18 x 10μ. Oocapt 20 in diameter. Vestibule at the point of union of the vagina with the oviduct. Vitelline duct expands into a reservoir 30μ in diameter. Vitelline follicles not in lateral fields, but continuous from joint to joint, 60 x 30 x 50μ in dimensions, about 700 in each proglottis. Uterus-sac elliptical in outline, directed anteroposteriorly in the natorior half of the proglottis where in gravid segments it occupies almost the whole of the medullary region; 2.20 x 1.34mm. in dimensions; in quadrate segments irregularly alternating from side to side as are the uterine openings.

Eggs, 75 x 40μ.

Habitat: In the anterior portion of the intestine of the host.

Host	Locality	Collector	Authority
Gadus merluccius (Type host)	Naples	Rudolphi	Rudolphi 1819:139
" "	--------	Leuckart	Leuckart 1819:45
" "	Patavia	Molin	Molin 1858:134
" "	Trieste	Stossich	Carus 1885:120
" euxinus	Trieste	"	Stossich 1899:1
Merlangus carbon-	Nizza	Wagener	Wagener 1854:61

Merlangus sp.		--------	Wagener	Wagener	1857:93
Merluccius	bilinearis	Woods Hole	Linton	Linton	1901:473
"	esculentus	------	Parona	Ariola	1896:265
"	"	Trieste	Stossich	Stossich	1898:115
"	merluccius	Pisa	Wagener	Wagener	1854:68
"	vulgaris	Ireland	Drummond	Thompson	1844:439
"	"	Pisa	Wagener	Diesing	1863:237
"	"	Padova	Molin D	Diesing	1863:237
"	"	Patavia	Molin	Molin	1861:235
"	"	Genova	Parona Ari	Ariola	1896:265
"	"	Portaferr-ajo, Id. Elba	Damiani	Parona	1899:8
"	"	Pisa	Parona	Parona	1899:8
"	"	Gaeta	Ariola	Ariola	1900:397
"	"	Augusta, Catania	Barbagallo & Drago	Barbagallo Drago	1903:412
Pomatomus	saltatrix	Woods Hole	Linton	Linton	1901:451
"A small hake"		Calf of Man, England	Johnstone	Johnstone	1909:87
Merluccius	bilinearis	Passamaquoddy Bay, St. Andrews, N.B.	Cooper	Cooper (the present paper)	
"	"				
"	"	Buzzards Bay, Mass.	"	"	
"	"	Vineyard Sound Mass.	"	"	
"	"	Casco Bay, Me. South Harpswell	"	"	

In external appearance this species is characterized by the globose nature of the scolex and the serrate margins of the strobila, the former of which was the basis of Leuckart's (1819 : 45) specific name and which with the latter was emphasized and included in the diagnoses of all the authors after Rudolphi (1819). But another important character which also assists in the ready recognition of the species is the presence of spurious articulations, which, however, are evidently not those mentioned collectively by Wagener (1854 : 69) as "articulatio spuria" (vide infra). The <u>scolex</u> (Figs. 73-77), as noted above, is divided by two longitudinal marginal grooves into two dorsoventral hemispheres, the bothria. The latter were considered by Rudolphi (1819 : 139, 477) and others to be marginal or lateral (but not "lateral") in position, which error was finally and definitely corrected by Luehe (1899 : 35); but Leuckart (1819 : 45-48) rightly described and figures the scolex as "medio marginali sulcato, foveis lateralibus ... " and "Die Randfläche des Kopfes ist breiter als die Seitenfläche, die Mittelfurche jener ziemlich tief, und bildet an jener Seite eine erhabene, in der Mitte hellere Wölbung." It seems that Molin (1881 : 235) fell into the error of considering the marginal or lateral grooves, separating the bothria, to be the bothria themselves, as indicated in his diagnosis: "Caput magnum subglobosum, utrinque sulco longitudinali laterali, apertura centrali bilabiata antica, bothriis ovalibus, subterminalibus, marginalibus, longis", and in his "Osservazione 2" he said: "Quantunque la testa sia molta grossa ed opaca, ciò non per tanto potei distinguere il solco menzionato da Diesing (1850 : 587) il quale però corrisponde ai la-

ti e non ai margini del corpo, e sembra dividere la testa in due emisferi. Ognuno di questi porta una fossetta oblunga, ovale, che si estende dall' apice a due terzi della lunghezza del corpo, e sembra di quattro quadranti suddivisi da due solchi che s'incrocciano." It is evident from his Fig. 2, Taf. V, that the "fossetta oblunga" is the entrance to the bothrium, but he does not seem to have observed the actual opening, not even in either marginal sulcus! Matz (1892 : 103) expressed the opinion that the bothria of this species were dorsoventral in position, while Ariola (1896 : 280) evidently on the basis of former diagnoses, placed the species among those of the genus Bothriocephalus Rud. with "Botridi marginali". Stossich (1898 : 115) also described the scolex as " ... subglobosa, con botridii marginali, subterminali, ovato-allungati"; and Ariola (1900 : 398) finally corrected his own view of the external structure of the scolex by saying that "Un esame anche superficiale dimostra però che la posizione degli organi di fissazione non e quale fu ritenuta, perchè ciascun d'essi corrisponde ad una faccia larga dello strobila, o como si dice, sono dorsoventrali. I pretesi botridii marginali sono dati da un solco circulare, abbastanza profondo, che corre a guisa di un meridiano attorno allo scolice globoso, passando per l'apice, e dividuendolo come in due emisferi, uno destro a l'altro sinistro," thus evidently ignoring the fact that Luehe had already (1899 : 25) performed the service for students of the group, as pointed out with justifiable emphasis by the latter (Ariola, 1901 : 414).

The bothria in this species are sac-like structures, formed phylogenetically, as indicated in the generic diagnosis, by the

rolling together of their edges or "walls" and the fusion of the latter for most of their extent "in such a manner that only a small lateral (dorsoventral) opening in the region of the apex leads into the interior of the spacious, hollow organ of attachment." The size and shape of the opening itself varies consierably in preverved material. It may be so small (Fig. 73) as to be seen only on very close examination or in sections, or comparatively large (Fig. 77), depending on the stage of contraction or enlargement of the bothria when the individual is fixed or preserved. During life it may be seen to undergo such variations in size while the whole scolex is being elongated and retracted during the characteristic sucking movements. Rudolphi (1819 : 477) correctly described the bothria as " ... oblonga profunda et magna in vivis; in mortuis bothrii ostium parvum anticum adesse videtur." In lateral view (Fig. 74) the bothria are seen to be more sharply oval or even conical in outline, as is consequently the whole scolex, owing to the fact that the dorsoventral diameter of the lumen of each is such greater in the posterior half than in its anterior half. It will also be noted more clearly from this aspect that the hinder borders of the bothria project a considerable distance beyond the true anterior end of the strobila, so that the length of the scolex is not that of the bothrium, as many writers have evidently taken it to be, but as far as can be determined from external views, more nearly that of the marginal sulcus, plus an extension of the same to the tip of the scolex, or, where the latter is retracted, to the anterior border of the labia. The breadth of the scolex was taken for the sake of convenience to be that of the

bothrium, since there is very little difference between the two in this regard.

The two apertures of the bothria are united over the tip of the scolex by a saddle-shaped groove, the edges of which are somewhat swollen so as to form lip-like structures. This groove has been described and figured for C. crassiceps by Molin (1861 : 235, Fig. 2, Tab. V) and Ariola (1900 : 397, Fig. 17, Taf. VIII) and figured by Linton (1910b : Fig. 267, Pl. 24), but it does not appear either in the figures given by Wagener (1854 : Fig. 75, Taf.7; 1857 : Fig. 6, Pl. II) or that by Johnstone (1909 : 87, Fig. 14). It is present in all of the writer's material even to the youngest, but in a few cases the tip of the groove, that is, the extreme tip of the scolex is so prominent as to more or less obliterate the lips (Fig. 77). It is also to be noted that the lateral grooves separating the bothria do not pass thru these lips, as nicely indicated in Ariola's figure but erroneously described (p. 398) as "passando per l'apice", and as further figured but in the same relation by Johnstone. Wagener's Fig. 75 and Linton's Fig. 266 also give the erroneous impression that this groove passes right over the tip of the scolex. Molin (1861 : 235), while giving a somewhat confused description (vide supra) of the relations between the saddle-shaped structure, which he figures as including the apertures of the bothria more posteriorly, and the lateral grooves, says that he saw in the apex an aperture which not only ended blindly but which was bounded by two eminences, simulating lips. This may have been due to extreme contraction of the tip of the scolex between the lips of this groove. It will be

recalled that F. S. Leuckart (1819 : 46) says in this connection that "An dem Kopfende ist eine kleine Vertiefung in der Mitte; die von den beiden sich hier vereinigenden Randfurchen herrührt, wodurch ihre Ränder etwas erhabener werden. Die Grübchen sind kaum von der Grösse eines Nadelknöpfchens und tief in Kopfe, so dass es fast scheinen könnte, als wären sie wahre oscula," but his Fig. 36, very good in other respects, does not do justice to his description of these terminal structures. Cf. also Loennberg's (1893 : 15-17) B. neglectus, the figure for the scolex of which looks very much like B. crassiceps.

There is no neck in this species, segmentation beginning immediately behind the scolex (Fig. 76) and being complete thruout the strobila, which characters are also given by Luehe (1899 : 44) for the genus: "Äussere Gliederung vollkommen, ein gegliederter Hals fehlt." As regards this quotation, it would appear that the "gegliederter" is either superfluous or a lapsus calami for "ungegliederter." The anterior border of the first segment, a greater part of which is obscured by the hinder edges of the bothria, is constantly somewhat narrower than the latter, but its posterior border is usually about the same width even in such contracted specimens (Fig. 73). Its outline is somewhat trapezoidal, while its length is slightly greater than that of the segment immediately following. The breadth of this first segment varies anteriorly from 0.40 to 0.92mm. and posteriorly from 0.65 to 1.16, -- Linton's measurements are 0.78 and 1.07, respectively. Following this the segments are closely set, five to six times as broad as long, while their somewhat thickened posterior borders protrude on either side

(as well as dorsoventrally) so as to give the strobila a serrate appearance (Fig. 76). It is here that the formation of new proglottides takes place by the subdivision of preexisting segments. This serrate appearance is also present in the posterior part of the strobila where the proglottides are quadrate to twice as long as broad. The measurements of the first proglottis showing eggs in the expanded end of the uterus (uterus-sac), in a fairly relaxed strobila (Fig.), was 0.50mm. long by 0.92 broad, while one further back where the uterine cavity was 0.61 x 0.48mm. was 1.31mm. long by 0.82 broad. These measurements are, however, of only relative value, since another strobila of the same age but contracted during fixation might show the same regions more like those farther ahead and thus, in alcoholic, specimens evidently younger. But posteriorly, however, each serration does not necessarily define the posterior border of a proglottis. This is due to the presence of spurious articulations, possibly included in Wagner's "articulatio spuria" (vide infra). These are furrows which arise laterally, where they do not stand out as distinctly, however, as the true posterior borders of the proglottides, but do not pass to the median line. They are not present in all of the posterior proglottides nor are they symmetrically arranged. In the following excerpt from his more complete diagnosis Rudolphi (1819 : 477) did not refer to these structures:

> "Articuli breves, margine posteriore incrassato utrinque extante, quo corpus serratum fit. Articuli ceterum inaequales, ut passim augustiores et longiores intercurrant."

while F. S. Leuckart said only that

"Die ersten Glieder am Kopfe schmaler als die Übrigen, dann folgen fast gleichbreite, die letzte Hälfte der Glieder breiter als lang, mit deutlichen, weissen Ovarien."

which refers to "der beschreibene nicht ganze Wurm ... 1-1/2" lang." Diesing (1863 : 236) described the strobila as

" ... ellipticum, articulis ad medium usque increscentibus, inde descrescentibus, marginalibus posticis utrinque prominentibus, articulo singulo plica transversali diviso ... "

which latter refers obviously to Wagener's "articulo spuria"; while it is also to be seen that, as regards the shape of the strobila, he was dealing with much contracted specimens, the length being cited as ranging from one and a half times to two inches. Ariola (1900 : 397) said:

"Strobila anteriormente assai piu stretto dello scolice, a guisa di peduncolo; le primi proglottidi sono rettangulari, strette, ma rapidamente si allargano; raggiunta la massima dimensione, la conservano sino all ultimo tratto del corpo, dove nuovamente si restringono. Le proglottidi mature hanno angula posteriori appena visibili; le ultime presentano forma trapezoidale."

and Johnstone (1909 : 89) stated that

"The posterior proglottides are much broader (in the transverse axis of the strobila) than they are

long (in the longitudinal axis of the strobila); and their anterior extremities are narrower than the posterior ones, so that the edge of the strobila appears to be serrated. Secondary segmentation of the proglottis often occurs."

In fine, Wagener, Diesing, and Johnstone are, to the writer's knowledge, the only workers who have referred to this spurious articulation or subdivision of the segments into false secondary segments, -- although Luehe (1902 : 629) repeated the statements of the first two authors. Furthermore Wagener did not figure the adult strobila of the species to show the structures in question, but in the legend for Fig. 78, Taf. 7 of Dibothrium heteropleurum, -- now, Amphicotyle heteropleura (Diesing) -- says only that "Man sieht die articulo spuria, welche die echten Glieder, wie bei Dibothrium crassiceps, in der Mitte theilt", and further, as regards the difference in structure of the sides of this species, "Der Schein entsteht durch die noch dichtere Zusammendrangung der Falten der wahren und falschen Glieder auf der concaven Seite." In his legend (p. 61) for Fig. 6, the egg of C. crassiceps, he also said: "Jedes Glied hat in der Mitte eine Falte, die ihm das Ansehen giebt, als bestunde es aus zwei Gliedern." Thus there is reason to believe that for this species no one (apart from Linton's Fig. 268) has as yet described nor figured what the writer here calls spurious articulations, but that these workers were referring to the secondary division of the segments of the anterior end of the strobila which proceeds in the manner

described for B. scorpii et al, altho not so clearly (Figs. 76 and 78). This is borne out by the fact that the spurious articulations described here never reach the median line of the strobila, much less pass completely across it as do the true posterior borders of the proglottides (Fig. 79). In one moderately relaxed strobila the first segment showing spurious articulations appeared 11.7mm. from the tip of the scolex, while in another which was quite contracted, especially anteriorly, 4.8mm. In the former case the next two pairs of these structures, -- and all of these in question happened to be bilaterially symmetrically situated, -- appeared in the fourth and thirteenth segments following.

The following table gives various external measurements of specimens in alcohol, which may be of use for comparison:

Number of specimen	204.1	204.2	204.3	204.4	221.1	259.1
Length	87mm.	92mm.	43mm.	Little more than scolex	29mm.	72mm.
Length of scolex (lateral view)	0.87	0.59	0.46	0.43	0.63	0.83
Length of bothrium	1.08	0.77	0.64	0.64	1.00	1.01
Breadth of scolex (bothrium)	0.75	0.57	0.52	0.53	0.67	0.90
Thickness of same	0.87	0.64	0.68	0.58	0.74	1.21
Breadth of Seg. I (anteriorly)	Much contracted	0.40	0.37	....	0.55	0.92
Ditto, posteriorly	Ditto	0.53	0.60	0.53	0.74	1.16
Thickness, posteriorly	0.37	0.38	0.24	0.27	0.52	....
Greatest breadth Anterior part of prog.	1.01	0.82	1.06	....	1.30	....
Posterior " " "	1.11	1.04	1.16	....	1.48	1.38

None of the above six specimens were considered to be complete posteriorly. The posterior proglottis will be dealt with below under the excretory system.

Posteriorly the uterus-sacs appear as a series of gradually enlarging, dark punctations, as desdribed below, not so pronounced, however, as in B. scorpii.

The cuticula varies in thickness from 2 to 5 μ, the most common measurement being about 2.6 μ. Resting on a distinct basement membrane, well shown after the use of Mallory's stain, it is divided into two strata of equal thickness by a granular layer, the components of which seem to be related to the bases of the stout, somewhat club-shaped bristles or "hairs" which constitute the outer moiety. While the inner stratum was found to be homogeneous with the stains used, the outer showed two intensities of color, an inner lighter and an outer darker. The former represents the narrowed central ends of the spindle- or club-shaped bristles, while the latter is determined by the well-stained bodies of the bristles themselves. Linton (1901 : 473) said that "the cuticula is covered with minute spines", but Johnstone (1909 : 89) said concerning these structures; "I can see nothing of this kind in the species before me." All over the scolex and in the form of a band on the posterior borders of the proglottides (Fig. 82) these bristles become modified into stouter spinelets from two to three times as long and everywhere directed posteriorly, quite like those described elsewhere (Cooper, 1914b : 85) for Haplobothrium globuliforme, but much longer relatively; thus indicating their function as accessory organs of attachment. The largest

spinelets are in the middle of this band, those at the edges, that is in the antero-posterior direction, gradually merging in length into the bristles of the cuticula of the neighborhood. Furthermore they are arranged in the same manner on the posterior borders of the spurious articulations and all the secondary segments situated in the anterior portion of the strobila. They were originally referred to by Wagener (1854 : 5) and later by Diesing (1863 : 236) ("articulo singulo ... postice ciliis instructo"), by Cohn (1902 : 55) and by Luehe (1902 : 238, 247) who considered "dass es sich nicht um in die Cuticula eingesenkte Stacheln handelt, wie bei dem Stachelkleide so vieler Distomen, sondern nur am Fortsätze der Cuticula, durchaus analog denjenigen, welche Looss an der bereits oben citierten Stelle fur Haematoloechus asper abgebildet hat.."

The cubcuticula, about 20 μ in thickness, consists of fairly elongated cells, the nuclei of which are situated at their central ends close to the vitelline follicles, while their boundaries are difficult to ascertain, the whole layer thus being more of the nature of a syncitium. For about one third of their length immediately beneath the cuticular the cytoplasm becomes broken up into a number of more or less parallel processes which stand out in distinct contrast with the deeper inner ends of thecells especially in transverse sections.

The parenchyma, everywhere encroached upon by the voluminous reprodutive organs, is in the form of a comparatively open reticulum showing no features of special interest. It is naturally most abundant in the posterior flared ends of the proglottides. In small strobila it is more compact in structure and has relatively more

nuclei in its meshes. Distinct spaces, formerly occupied by calcareous bodies, such as are readily and distinctly seen in the parenchyma of B. scorpii, were found neither in the scolex nor in the strobila; nor were these structures noticed in living material.

The musculature is composed of the typical three sets of fibres, interferred with in the usual manner by the large reproductive organs and their external openings. The sagittal and coronal series are only moderately developed, while the longitudinal series if about 10μ in thickness and situated within the coronal series. Its fibres are arranged in bundles of irregular shape (in cross-section) and width but of this uniform thickness, excepting where they are naturally much flattened out dorsally and ventrally by the distended uterus-sac. Otherwise they are continuous from joint to joint. A very weakly developed series of outer longitudinal muscles is also present while the muscles of the posterior border of the proglottis (vide Luehe 1897a) are poorly developed, in fact even less so than in Bothriocephalus, s.str. The cuticular musculature is typical.

In the scolex the coronal fibres are better developed than the sagittal ones and pass around the bothrium closer to its lumnn than in its external surface, while the latter are mostly confined to the region between the bothria. The inner longitudinal muscles of the strobila pass forward into the scolex, dividing as they meet the lumen of the bothria to pass around them and attach themselves to the margins of the apertures. They are thus directed somewhat obliquely as shown in Johnstone's Fig. 18 and described as " ... running irregularly, probably obliquely, round the walls of the

bothrium. These no doubt function as constrictors of the latter." A few pass on forward to the tip of the scolex to assist in activating that region. Between the bothira, however, they were found to be separated into dorsal and ventral layers as in the strobila, and not united into a single coronal band as shown by Johnstone. The bothrial sphincter (Fig. 76) is a powerful bundle of fibres, about 0.07mm. in transverse section surrounding the aperture close to its cuticula. In transverse sections of the scolex it appears as a deeply staining mass on each side of the opening, also shown in Johnstone's Fig. 15. As it crosses the aperture anteriorly it becomes greatly attenuated, which fact with its comparatively great size at the sides and posteriorly accounts for the almost complete disappearance of the aperture in many adult, preserved scolices owing to the powerful contraction of this muscle from behind forward thus diminishing the opening towards the tip of the scolex. From their arrangement it is to be seen that this sphincter, evidently a modified group of coronal fibres, and the longitudinal muscles in the scolex play a more important role in the movements of the bothria than do the other groups. On account of the oblique course of the longitudinal fibres they would evidently act in diminishing the size of the lumen of the bothrium as well as would the circular (coronal) fibres of the latter.

The nervous system consists of two longitudinal strands which enlarge in to tip of the scolex to form two somewhat elongated ganglia, united by only a few fibres but sending out comparatively large nerves to the bothria. In the strobila the chief strands, each from 15 to 30 μ in diameter, are situated ventrally in the

medullary parenchyma just within the longitudinal muscles and from one-fifth to one-quarter the width of the strobila from its lateral margins (Fig. 80). About half way along the scolex the strands are about 80μ in diameter, while the somewhat smaller ganglia are close together about 0.15mm. from the summit. In other words the chief strands enlarge and diverge gradually until the equatorial region of the scolex is reached and then diminish in size as they converge to form the ganglia. A pair of prominent nerves is sent forward on each side to supply the saddle-shaped groove described above. In young strobilae the nerve strands are situated midway between the dorsal and ventral surfaces, and not ventrally.

The excretory system consists of a pair of longitudinal vessels, situated ventrally, that is in the same frontal plane as the chief nerve strands, each vessel being in the anterior end of the strobila about half way between the nerve strand and the median rows of reproductive rudiments. These vessels break up in a very irregular manner into extremely elongated loops, so that for considerable stretches four vessels will appear while again the branchings will be so numerous as to make it very difficult to decide, on looking at a transverse section, which are the main channels (Fig. 76). In other individuals four vessels appear, so that we must conclude that the pair just mentioned represent the latter fused at times but separated again to form the loops. But whether these four vessles represent the typical four of other orders it was found impossible to decide, excepting from comparisons with other species of this order. These main vessels may continue back

into the ripe joints close alongside the uterus-sacs, but they usually break up into a very diffuse reticulum throughout the medullary parenchyma in the region where the openings of the cirrus and vagina pierce the cuticula in development. Behind this region it was found impossible to trace the main vessels with satisfaction. The system usually passes into the scolex as two vessels, but soon breaks up into an elaborate reticulum which ramifies between the bothria and throughout their walls. These branches are shown in Johnstone's Fig. 15. As regards the conditions of the excretory system in the extreme posterior end of the btrobila, the material at hand permits of only negative conclusions. In the youngest strobilae, such as that shown in Fig. 77, the vessels converge posteriorly to open into a notch in the cuticula, there being no definite pulsatile vesicle such as is present in plerocercoids of the genus Proteocephalus, for instance. From this and the further fact that Wagener (1857 : 93) showed (Fig. 6, Pl. II) the main vessels in a very small strobila, which he examined while it was alive, passing separately to the outside, we are led to conclude that the vesicle, if every present, must have been situated in the walls of an enveloping cyst and disappeared with the latter as in the Trypanorhyncha or the Cyclophyllidea. This seems to have been Wagener's idea of the situation when under his Fig. 65 (1854 : 68) he said: "Man sieht keinen pulsirenden Schlauch am spitzen Schwanzende. Es muss dies Thier auf ähnliche Weise entstanden sein, wie das in Fig. 74 dargestellte," and Fig. 74 is that of "Dibothrium (Belones?)" from Scyllium canicula enclosed in a cyst in the walls of which "man sieht der Gefässe der Cestodenblase."

The earliest reference to the genitalia of C. crassiceps was by Rudolphi (1819 : 477) where he said:

"Ova vel ovalia vel ovata, forsan secundun majorem maturitatis gradum. A B. punctato diversissimus, licet ovaria lateralia fuscescant, sed haec ipsa etiam in B. crassicipite quam in B. punctato majora sunt."

The structures called ovaria were evidently the uterus-sacs. F. S. Leuckart (1819 : 46) described the reproductive organs of his B. pilula as follows:

" ... die letzte Hälfte der Glieder breiter als lang, mit deutlichen, weissen ovarien. An den uteren Gliedern sieht man oberhalb jedes Eierstockes einen wasserhellen Punct, wahrscheinlich Oeffnung fur das mannliche Zeugungsglied."

From a comparison of this with his description and figure of posterior proglottides of B. scorpii, it is evident that he too was dealing with the uteri and their openings respectively. He also referred to " ... den schwarzen Puncten des Korpers, die Rudolphi fur Ovarien gehalten" of Redi's worm, which Rudolphi called (1810 : 67) Bothriocephalus Gadi merluccii and placed in his "Species dubiae." Wagener (1854a : 61) said that

"Die Eier Häufen sich in obersten Theile der Glieder an. Der Dotterstock verzweigt sich uber das ganze Glied und liegt overhalb des vescicules transparentes van Beneden. Die Geschlechtsöffnung ist in der Mitte und lateral."

Diesing (1863 : 236) placed the "Aperturae genitalium laterales in linea mediana." Ariola (1896 : 265-266) gave the first comprehensive description of the reproductive organs in the following words:

> "Tuttaria sul corpo si osservano macchie scure molto sporgenti, constituite della massa di uova. Tali rilievi non sono propriamente, nella linea mediana, ma collocati a destra o a sinistra di essa, formando in tal modo une striscia a zig-zag.
>
> L'aperture genitale maschile sbocca sulla faccia dorsale, e sulle opposta si apre l'utero.
>
> In alcune proglottidi l'ovario e bilobo, la uova sono ellissoidali e mancano di operculo."

Luehe (1899 : 42-44) in defining the characters of the genus gave the general features of the genitalia, while Ariola (1900 : 397) enlarged his own 1896 description: "Ovario con numerose uova, talora bilobo; uova ellissoidali aventi nel diametro longitudinale 67 e nel trasversale 32 ... " Braun (1900) reviewed the literature on the genus and species up to date, and Volz (1900) discussed the reproductive organs of the species as compared to those of his B. spiraliceps and the position of the openings in connection with brief remarks on the phylogeny of the genus Bothriocephalus s.lat. As regards his own specimens Linton (1901 : 473) said that "Posterior segments show rudiments only of the reproductive organs, but no indication of external genital openings." And later Johnstone (l.c. : 89) remarked that "the genital openings are in the middle line of the proglottides but near the anterior borders of the

latter," referring evidently, as will be seen later, to the uterine openings only.

The rudiments of the reproductive organs appear about three millimetres from the tip of the scolex as aggregations of nucleu that can just be discerned in toto mounts (Fig. 76). About three millimetres farther posteriorly in moderately contracted (such as would be obtained if no special care were taken during the fixation of the material) older strobilas the cirrus and vagina are seen to be just piercing the dorsal surface. Before this region is reached, however, the common rudiment, at first circular and then elongated oval in outline, differentiates into a more anterior portion, the rudiment of the whole uterus, a more posterior less elongated part, the beginnings of the cirrus-pouch and vagina, and a third, connecting the other two near the hinder edge of the proglottis, the nuclear aggregation that will develop into the ovaries and the organs of the interovarial space (Fig. 79). As mentioned above in the specific diagnosis, the first two of these rudiments alternate irregularly from side to side as do the corresponding adult structures. At the same time the testes and vitelline glands are developing in the medullary and cortical portions of the parenchyma, respectively.

A distinct genital sinus or cloaca, the opening of which is usually almost circular in outline, is present (Fig. 82). It varies from 0.05 to 0.09mm. in diameter and is situated, as above noted, nearly in the median line, dorsally, and from three-fourths to one-half the length of the proglottis from its anterior border, usually just posterior to the spurious articulations when they are

present. At the bottom of this sinus there is a secondary cloaca ("Geschlechtstasche" or "Ductus hermaphroditicus"), also circular in outline, from 15 to 25 μ in diameter, and into it open the cirrus and vagina quite close together, the latter immediately behind the former. This secondary sinus is best seen in sagittal sections (Fig. 82). The genital pore (the opening of the main sinus) is elevated slightly above the general dorsal surface of the immediate neighborhood, thus appearing as a low cone or crater. No sphincters were found to control the openings of either of these sinuses but the cuticula of the floor of the larger or outer was seen to be modified into coarse, low, rounded and close set papillae which are evidently of special importance during copulation. As regards the latter it was concluded that these papillae would sefve to temporarily fasten the structure into the primary sinus of another proglottis, when it is possibly everted with the sirrus. Nothing was observed on copulation in this species during life nor were any cases of protruded cirrus met with in the material at hand.

All of the proximal portions of the reproductive organs, excepting the vitelline follicles, are located in the medullary parenchyma, although the much distended uterus-sac, originally in the latter, extends almost to the cuticula on both the dorsal and ventral surfaces. Fig. 81 shows their arrangement in toto.

The testes are closely arranged in the medullary parenchyma in two lateral fields, each bounded laterally by the junctions of the dorsal and ventral layers of longitudinal muscles and medially by the other reproductive organs (excepting the vitelline glands) which occupy in the quadrate proglottides about the middle one-third

of the transverse diameter of the strobila and are contiguous from joint to joint. In the quite mature elongated proglottides the testes are ellipsoidal in shape, averaging 0.125mm. in length by 0.040 in diameter, the cross-section being usually about circular in outline. In younger joints and in all those of much contracted strobilae the testes are nearly spherical in shape, measuring about 60 μ in diameter, or often slightly longer than broad. They are arranged in a single layer in the medulla, the whole dorsoventral diameter of which they occupy, and are continuous from proglottis to proglottis. From 3 to 4 appear in each lateral field in transverse sections, from 5 to 7 are seen in sagittal sections between the posterior borders of consecutive proglottides, while, so far as could be determined from coronal series directly, the number is from 20 to 25. Thus each proglottis contains from 40 to 50 testes.

The vas deferens forms a wedge-shaped mass of closely arranged coils, extending forward immediately ahead of the cirrus-pouch and alongside the uterus-sac for about two-thirds of its length (Fig. 81). In proglottides in which the latter is yet comparatively small the vas deferens may pass forward as far as its anterior end. In either case it forms with the cirrus-pouch a mass which alternates from right to left with the uterus-sac. When distended with sperms the duct averages about 30 μ in diameter; but just before it enters the cirrus-sac anterodorsally it narrows down to 5 μ. Immediately within the wall of the latter it often enlarges again to form a thin-walled functional vesicula seminalis, or perhaps more correctly ductus ejaculatorius, from 15 to 23 μ in diameter. After one or two short turns it diminishes again to about

$8\ \mu$ and then passes on as the cirrus proper. While the proximal portions of the duct do not pass in any definite direction, the latter is situated for most of its length in the longitudinal axis of the pouch and is about 0.10mm. long. About 20 to $25\ \mu$ at its middle, it is lined with a cuticula, $10\ \mu$ thick, which is cleft but not armed with bristles of any kind.

The cirrus-sac (Fig. 32) situated immediately behind the uterus-sac or lateral to its posterior end, is elliptical to slightly oval in outline, and measures 0.138-0.162mm. long, 0.087-0.116mm. wide and 0.098-0.116 deep. The longitudinal axis is directed anterodorsally from the genital sinus and to the right or left, according as it alternates with the uterus-sac. The proximal one-third of the contents of the pouch consists of loose parenchymatous tissue with a few muscle fibres surrounding the ducted ejaculatorius, while the distal two-thirds, that part which accommodates the cirrus proper, is supplied mostly with muscles which actuate the latter. Large fibres proceed somewhat obliquely from the wall towards the proximal pole of the sac to become broken up or frayed before they are attached to the cirrus tangentially, so as to give the appearance in frontal sections of the latter being surrounded by a comparatively heavy layer of fine lightly staining circular fibres. A few of the fibres closest to the cuticula of the cirrus were considered to be true circular fibres; but no longitudinal fibres were seen. The wall of the cirrus-sac is from 2 to $3\ \mu$ thick and is made up of very fine closely matted fibres, the direction of which could not be determined with satisfaction. The sac lies freely in the parenchyma of the region and is not connected

by any special muscles to the dorsal or ventral body-walls; nor are the body muscles attached to it as in some cestodes. The layers of the latter are simply pierced and the fibres turned aside in evidently a passive manner.

The opening of the vagina is close behind that of the cirrus at the bottom of the secondary genital sinus, or as it has been called by Fuhrmann, "ductus hermaphroditicus" (Fig. 82). From this point the duct courses ventro-posteriorly in the mid-line and then parallel to the dorsal surface of the proglottis until it reaches the ovarian isthmus, above which it makes a few turns and quickly diminishes from 20 μ in diameter half way along its course to 10 μ. It then dips farther down into the genital space, often enlarging slightly as it does, and soon joins the oviduct at an enlargement of the latter situated a short distance behind the oocapt. Throughout its length it is lined with a ragged or pseudociliated cuticula and surrounded by radially arranged nuclei connected with the cuticula by cytoplasmic strands like those described by the writer for H. globuliforme (l.c. : 105) and considered to be possibly extruded nuclei of the original epithelium as well as the myoblastic nuclei of circular fibres, a layer of which surrounds the duct. There is no vaginal sphincter.

In his generic diagnosis Luehe said that the receptaculum seminis is small and in his description of the family, Ptychobothriidae (1902 : 327) that when present it is "in Gestalt eines kleinen Blindsäckchens ausgebildet, welches parallel neben dem Endabschnitte des Oviduktes liegt and mit der Vagina unmittelbar vor deren Vereinigung mit dem Ovidukt in Verbindung steht." In the sec

sections at hand, however, it is a comparatively large structure and very difficult to orient in sections made in any direction. It is in the form of a thin-walled sack about 60x30 μ , wrapped somewhat spirally around the dorsal wall of the above-mentioned enlargement of the oviduct and opening by an aperture equal to its whole diameter into the vagina just at its juncture with this vestibule. But since the vagina constantly constricts a second time to a diameter of about 8 μ before entering the latter, one gets the impression of the receptaculum seminis being a diverticulum of the oviduct rather than of the vagina. Fig. 83, of four consecutive sections of a transverse series, showing the union of these ducts, will give a better idea, perhaps, of the nature of the seminal receptacle.

In mature proglottides the ovary (Fig. 80) is a bilobed structure situated in the median line, close to the posterior border of the proglottis and immediately ahead of the uterus-sac of the proglottis following, where the latter is much distended with eggs (Fig. 81). In toto mounts the lobes seem to be quite separate from each other and apparently unconnected, but in sections the isthmus is easily made out. It occupies the ventral half of the medulla while the wings or lobes extend completely across the space betweenthe layers of longitudinal body muscles. The lobes are about 0.27mm. long by 0.13 wide, while the isthmus is 0.06-0.08mm. in anteroposterior diameter. These proportions are, however, much different in such contracted strobilae or in proglottides in which the uterus-sac is distended with eggs. In both instances the ovary is very much flattened anteroposteriorly and, in the latter case,

all but obliterated, as shown in Luehe's Fig. 8 (1903 : 326). The ova from the isthmus where they are ready to be passed on by the oocapt, are elliptical to oval in outline in sections and measure on the average 18 x 10 μ, their nuclei being about 9 μ in diameter.

The oocapt, situated in the median line at the posterior border of the ovarian isthmus, somewhat dorsally, is a spherical to ovoid muscular organ, about 20 μ in diameter (Fig.). Immediately behind it the oviduct constricts to a diameter of only 7 μ to 10 μ and then passes on posteriorly and ventrally either to the right or to the left, gradually enlarging until the above-mentioned vestibule is reached, when the diameter is 25 to 30 μ. The latter enlargement does not seem to be a direct continuation of the oviduct but a more or less separate thin-walled structure, -- the walls of the oviduct up to this point being comparatively thick (Fig. 82) -- into which the oviduct opens by a slightly elongated aperture. While the wall of the first portion of the oviduct is quite thick, comparatively speaking, and consists of more or less cubical ciliated cells with somewhat indefinite boundaries, -- ordinarily they stain very densely, -- the vestibule has, like the receptaculum seminis, a thin wall from which only a few scattered nuclei protrude into the lumen. The oviduct continues posteriolaterally and ventrally from one corner of the vestibule -- that with which the vagina is usually connected, -- as a tube quickly diminishing from 15 to 10 μ in diameter and lined with a ciliated epithelium with prominent nuclei but no distinct cell-boundaries. Close to the anterior wall of the uterus-sac of the next proglottis it turns upward sharply and at about the middle of the dorsoventral

diameter of the medulla takes on the vitelline duct. It then skirts the uterus-sac, just mentioned, as it passes to the opposite side of the generative space and slightly forward to soon become surrounded by the shell-gland.

The vitelline duct at its union with the oviduct has a diameter of 8 μ, but just beyond this, in the direction of the follicles, it soon enlarges to form a somewhat irregular vitelline reservoir which when filled with yolk may attain a diameter of 30μ. Its general course is towards the opposite side of the generative space almost parallel to either surface of the body; but beyond this it could not be traced with satisfaction.

The vitelline follicles fill up almost the whole of the cortical parenchyma from the layer of longitudinal body muscles to the nuclei of the subcuticula, the thickness of the stratum averaging 0.05mm. (Fig. 80). They form a continuous layer around the margins of the proglottides (in transverse sections) and also from proglottis to proglottis, as mentioned above, even extending well into the posterior borders. They are not arranged in lateral fields, but are interrupted only where the uterus-sac and genital sinus pierce the body-wall, or in the former case greatly press against the latter. The individual follicles attain a size of 60μ long, 30 μ wide and 50μ deep (the thickness of the whole layer), and are very closely crowded together. The number in cross-sections of the proglottis averages 55 and in sagittal sections 13, thus making the average total number for each proglottis 715.

The shell-gland is situated in the dorsal portion of the genital space, that part of the oviduct showing the connections

being almost horizontal in position and about 18 μ in diameter, that is, a little larger than the oviduct behind that region. The individual cells of the gland are much attenuated, closely arranged and have their nuclei situated in their slightly enlarged distal ends. Their connections with the oviduct give the wall of the latter a honeycombed appearance when it is seen in longitudinal section.

Beyond this region the oviduct gradually enlarges as it passes above the ovarian isthmus to become the uterine tube, the coils of which are accommodated opposite the cirrus pouch just behind the uterus-sac. As it proceeds its wall gets thinner, the nuclei protrude more and more into the lumen until many of them are evidently lost. It is noteworthy that the uterine tube in many cases as well as the uterus-sac especially in younger proglottides, alternates irregularly from right to left according as the cirrus and vas deferens do. These three structures are, in fact, fitted very nicely into the space between the uterus-sac ahead and the ovarian isthmus behind.

The uterus-sac is elliptical in outline, has its longitudinal axis directed anteroposteriorly, and is situated in the anterior half of the proglottis where in very mature segments it occupies almost the whole of the medullary region, or to be more precise, the middle three-fifths of the diameter of the proglottis, its anterior end extending forward close to the ovarium of the proglottis immediately ahead (Fig. 81). Luehe (1902a : 326) figured the uterus as, to use his own words, " ... in der Regel eine geräumige Uterushöhle bildend, welche die übrigen Genitalorgane, ohne

dass freilich deren Rückbildung eintritt, buchstäblich an die Wand drängen kann, indem die ganze Proglottis in reifen Proglottiden vielfach als ein einziger sackförmiger Eibehalter mit verhältnissmässig sehr dünnen Wandungen erscheint." But such a degree of restriction of the other genitalis was seen only in a few of the ripe proglottides of strobilas much contracted longitudinally. Here the largest uterus-sac measured 0.8mm. wide by 0.67 long, while the width of the proglottis in question was, at the posterior borders of the spurious articulations, 1.57mm. In fairly relaxed strobilas it increased in dimensions from 0.18 x 0.14mm., where the first eggs appéared in the lumen, to 0.87mm. long by 0.48 wide, where the proglottis was 0.80mm. wide at its middle, in the latter case, of course, pressing against the dorsal and ventral walls even as far as the cuticula. From a comparison of these measurements and the further fact that in the case of the former much contracted strobilae there often appeared behind the region showing the nearly obliterated genitalia a more relaxed one in which the relations of the uterus-sac to the other organs was quite as in the completely relaxed strobilas, one would be inclined to conclude that the characters of the family above quoted, would apply to this species only in the case of proglottides much contracted longitudinally. In the quadrate proglottides the smaller, that is, younger sacs alterate irregularly from right to left, as do the uterine openings, and according as the cirrus pouch and the vas deferens in particular (on account of its above-mentioned position) occupy the opposite sides of the proglottis. Externally, in alcoholic specimens, the uteri appear as a gradually enlarging series

of brown punctations caused by the contained eggs showing through the thinned body wall, as pointed out originally by Rudolphi and other writers.

The wall of the uterus consists of a thin membrane on the inside of which a very few scattered and somewhat flattened nuclei indicate its original epithelial nature. In young proglottides, where no eggs are to be seen in the small uterine cavities, the wall was found to be composed of an epithelium about 8 μ thick, showing prominent nuclei but no distinct cell-boundaries. Furthermore in such early stages the lumina of the uterine ducts, developing in the manner described by Young and Shaeffer, are not completely formed nor in connection with the cavities of the sacs, but the uterine apertures are prominent. In the first two or three sections of a 10 μ coronal series, taken from the ventral surface, they appear as distinct somewhat elliptical apertures about 36 μ in transverse diameter, but in the third or fourth section are closed, only to reopen as the cavity of the uterus-sac, thus showing that the membrane closing the aperture is only about 10 μ thick. And this closed condition is maintained until the uterus-sac attains the above-mentioned maximum size and becomes greatly distended with eggs. Then the functional opening is established by the rupture of the membrane which has meanwhile reached a length of 0.046 -- 0.058mm. by a width of 0.034-0.046, its elliptical outline having been retained. The opening does not become as regular in outline, however, as the membrane, for the latter remains around the rim as ragged processes, which render the determination of the exact location of the aperture in toto mounts a matter of no little difficulty.

The uterus opening is surrounded by a series of radiating cells like those of the opening of B. scorpii described above.

The fresh eggs examined in saline solution were found to be elliptical to ovoid in shape, 75 by 40 μ in dimensions and provided with a thin very light brown shell having no operculum. The color was so faint that it could be seen to advantage only when the eggs were in masses or in the uterus-sac. Ariola (1900 : 397) gave the measurements of the eggs of the European species as 67 x 32 μ. The largest examined were immature, the contents consisting of large spherical cells like those shown by Wagener (1854a) in his Fig. 6, Taf. I, among which no traces of the hooks nor division into oncosphere nor mantle could be seen. When the scolices of the worm are still attached to the wall of the intestine of the host between the mucous folds, they were found to often discharge many of their eggs from most of the posterior proglottides when the scolices were irritated with a blunt needle inorder to make them loosen their hold, which incidentally is a comparatively firm one as one might gather from the structure of the scolex.

As regards the life history of the species nothing definite was determined. 44 specimens of Merluccius bilinearis were examined at Woods Hole and at Harpswell, but no definite idea of a possible intermediate host was obtained. It was noticed, however, that when the intestine of the fish contained much grey chyle, presumably the result of the digestion of small herring, -- definitely ascertained at South Harpswell to be such in a few cases, and of the Blueback, Pomolobus aestivalis (Mitchill), -- no tape-worms of this species were present; but where amphipoda were found in the

stomach or the remains of such in the intestine the worm was plentiful. Furthermore, where nothing was found in either stomach or intestines, other than yellowish chyle in the latter, -- as in most fish examined -- indicating amphipods and other small crustaceans as food rather than small herring, the worm was also common. All stages from the youngest strobilae, such as that shown in Fig. 77, to the oldest were found, but none nor any plerocercoids, if such is the nature of the larva, were met with in the course of the thorough dissection of the available stomach contents of the host, both fish and crustaceans. In a number of cases, nevertheless, only very young strobilas were found in the intestine of the host, thus pointing to possible sudden infections at different times. Wagener, who figured the youngest strobila, nothing much more than the scolex, that has yet been recorded, says nothing more concerning the life history than that, on account of the excretory vessels opening separately to the exterior in this very young specimen, there might possibly have been a venicular appendage to the larva in the nature of an enveloping cyst comparable to that described and figured for "Dibothrium (Belones?) "from Scyllium canicula, concerning which he said (p. 45): "Vergleicht man diese Form von Cysticercus mit den vorigen, so ergiebt sich, dass der Unterschied nur in dem Aufhängebeutel sich findet, der Kopf und Blase verbindet" (Cysticercus fasciolaris Rud.)

A detailed description of the species is here given, not only because it is evidently the only one belonging to the genus, but because such seems to be quite lacking from the European literature, which made the determination of the species here a matter

attended with considerable uncertainty. The writer, however, considers that so far as the published accounts and reports of the species go, we must look upon the form on this side of the Atlantic to be the same as the C. crassiceps of Europe.

The material studied consisted of eight lots in the writer's collection from Merluccius bilinearis as above listed.

Subfamily 2. AMPHICOTYLINAE Luehe, 1902.

Scolex with two typical, mostly not very deep bothria, which can nevertheless develop posterior,sucker-like portions. In an isolated case a pseudoscolex is substituted for the scolex. External segmentation insignificant, at times disappearing thru accessory wrinkling or folding of the surfaces of the proglottides. Opening of cirrus and vaginal marginal, irregularly alternating, with more or less strongly pronounced tendency to unilaterality. Uterus-opening median; uterus-sac always well developed. Coiling of vas deferens strongly expressed.

Occurrence: In fishes.

Type genus: Amphicotyle (Diesing,1864) Ariola 1900, e.p. Luehe 1902.

Genus 1. Abothrium van Beneden, char. emend. Luehe, 1899.

Taenia (part.)	Auctorum.	
Rhytis (part.)	Zeder,	1803.
Bothriocephalus (part.)	Rudolphi,	1809.
Bothriocephalus (part.)	Rudolphi,	1819.
Bothriocephalus (part.)	Leuckart,	1819.
Bothriocephalus (part.)	Dujardin,	1845.
Dibothrium (part.)	Diesing,	1850.
Bothriocephalus (part.)	Baird,	1853.
Dibothrium (part.)	Diesing,	1863.

<u>Bothriocephalus</u> (part.)	Olsson,	1867.
<u>Abothrium</u>	Beneden,	1871.
<u>Abothrium</u>	Moniez,	1881.
<u>Dibothrium</u> (part.)	Linton,	1890.
<u>Abothrium</u>	Loennberg,	1891.
<u>Bothriocephalus</u> (part.)	Matz,	1892.
<u>Bothriotaenia</u> (part.)	Ariola,	1896.
<u>Bothriotaenia</u> (part.)	Riggenbach,	1896.
<u>Abothrium</u>	Luehe,	1899.
<u>Bothriotaenia</u> (part.)	Ariola,	1900.
<u>Abothrium</u>	Luehe,	1900.
<u>Abothrium</u>	Luehe,	1910.

Generic diagnosis: Scolex not exceptionally elongated, with two powerful but not especially deep bothria. Segmentation in older portions of the strobila mostly insignificant on account of superficial wrinkling of the individual proglottides; ripe proglottides essentially broader than long. Longitudinal nerves the lateral borders, dorsal to the cirrus-sac and vagina. Testes exclusively between the nerve strands. Vitelline follicles of very irregular shape, in two broad lateral fields, in part at least between the bundles of the longitudinal muscles, the follicles of individual proglottides not especially separated from one another. Ovary scarcely lobed, more or less bean- or kidney-shaped. Shell-gland dorsal to the ovary. Uterus-sac in ripe proglottides an

undivided cavity, occupying the whole of the medullary parenchyma. The openings of the uteri correspond to a more or less prominent median longitudinal furrow of the chain of proglottides.

Type species: A. rugosum (Batsch).

Species 1. Abothrium rugosum (Batsch,1786).
(Figs. 84 – 92.)

1773	Taenia decempollicaris	Strussenfelt	1773 : 27
1781	Taenia tetragonoceps (part.)	Pallas	1781 : 88
1782	"Der runzlichter Fischbandwurm"	Goeze	1782 : 410
1786	Taenia rugosa	Batsch	1786 : 208
1788	Taenia tetragonoceps (part.)	Schrank	1788 : 46
1790	Taenia rugosa	Gmelin	1790 : 3078
1802	Taenia rugosa	Rudolphi	1802 : 107
1803	Rhytis conoceps	Zeder	1803 : 292
1810	Bothriocephalus rugosus	Rudolphi	1810 : 42
1816	Bothriocephalus rugosus	Lamarck	1816:168
1819	Bothriocephalus rugosus	Rudolphi	1819 : 137
1819	Bothriocephalus rugosus	Leuckart	1819 : 57
1845	Bothriocephalus rugosus	Dujardin	1845 : 618
1850	Dibothrium rugosum	Diesing	1850 : 591
1853	Bothriocephalus rugosus	Baird	1853 : 88
1863	Dibothrium rugosum	Diesing	1863 : 239
1867	Bothriocephalus rugosus	Olsson	1867 : 53
1871	Abothrium gadi	Beneden	1871 : 56
1881	Abothrium gadi	Moniez	1881 : 167

1889	*Bothriocephalus rugosus*	Linstow	1889 : 242
1889	*Bothriocephalus rugosus*	Monticelli	1889 : 68
1890	*Dibothrium rugosum*	Linton	1890 : 750
1890	*Abothrium rugosum*	Loennberg	1890 : 22
1891	*Abothrium rugosum*	Loennberg	1891 : 75
1892	*Bothriocephalus rugosus*	Matz	1892 : 113
1894	*Bothriotaenia rugosa*	Blanchard	1894 : 701
1896	*Bothriotaenia rugosa*	Ariola	1896 : 280
1896	*Bothriotaenia rugosa*	Riggenbach	1896 : 223,228
1898	*Bothriotaenia rugosa*	Muehling	1898 : 35
1899	*Abothrium rugosum*	Luehe	1899 : 39
1900	*Bothriotaenia rugosa*	Ariola	1900 : 432
1900	*Abothrium rugosum*	Luehe	1900a: 101
1901	*Dibothrium rugosum*	Linton	1901 : 412,476
1903	*Bothriotaenia rugosa*	Schneider	1903a: 7
1910	*Abothrium rugosum*	Luehe	1910 : 26

Specific diagnosis: With the characters of the genus. Large cestodes with maximum length, breadth and thickness of 1000, 7 and 2mm.,respectively. Scolex present only in very young strobilas, when conical and provided with very weak bothria, changing with age to a pseudoscolex of various shapes, usually imbedded in pyloric coecum of host. Proglottides at first broad and very short, obscured by irregular transverse and longitudinal rugae, then gradually lengthening with age until finally they are quadrate or longer than broad.

Cuticula 5 μ thick, subcuticula 0.14mm. Small calcareous bodies, 20 μ in length. Longitudinal muscles in bundles, transverse forming septa between proglottides. Nerve strands dorsal to cirrus and vagina, 45 μ in diameter. Two chief excretory vessels anteriorly, passing into 30-35 posteriorly.

Genital cloaca irregularly alternating, between first and second thirds of edges of proglottides. Vagina opens immediately behind the cirrus and slightly ventral; no hermaphroditic duct.

Testes in two lateral fields, discontinuous from proglottis to proglottis, ellipsoidal, flattened anteroposteriorly, 40 x 90 x 85 μ, and 45 to 60 in number. Vas deferens lateral to uterus-sac with few coils before entering the cirrus-sac, 350 x 70-80 μ. Cirrus-sac ovoid with narrow end outward, 174 to 277 μ long by 92 to 108 in diameter. Cirrus straight in outer half of sac, proximally coiled or dilated.

Ovary large, entire, kidney-shaped (isthmus as thick as the wings), 0.6mm. wide, occupying the posterior half of the median portion of early mature segments. Ova conspicuous, nuclei large, 10-13 μ in diameter. Oocapt 34 μ in diameter. Beginning of oviduct Z-shaped. Right and left vitelline ducts join ventrally; common duct acts as reservoir. Vitelline follicles entirely within longitudinal muscles, discontinuous, intermingling laterally with the testes, irregular in shape and size, largest 30, 90 and 70 μ in length, width and thickness, respectively. Shell-gland compact. Uterine duct with only a few coils close to the median line; uter-

us-sac occupies the whole of the dorsoventral diameter of the medulla, very wide and short or irregularly circular or quadrate superficially, often lobed, 0.75 to 1.6mm. in transverse diameter, constantly rounded laterally; openings in median zig-zag row.

Eggs, 80 - 98 μ long by 75 - 92 wide, shell quite transparent.

Habitat: Intestine of the host with pseudoscolex imbedded in a pyloric coecum.

Host	Locality	Collector	Authority	
Gadus mustela	-----------	Borke	Goeze	1782:410
" "	-----------	Wagler	"	" :411
" aeglifinus	Warberg	Olsson	Olsson	1867:54
" "	Bergen	Loennberg	Loennberg	1890:22
" "	Grafverna & Wäsot	Olsson	Olsson	1893:17
" "	Arctic Ocean	Zool.Mus.d. K.Akad.Wiss. Petrograd	Linstow	1901:281
" "	England	Nicoll	Nicoll	1907:71
" callarias	Woods Hole, Mass.	V.N.Edwards	Linton	1897:431
" "	Arctic Ocean	Zool.Mus.d. K.Akad.Wiss. Petrograd	Linstow	1901:281
" "	Murman-Küste	"	"	1903:19
" "	Nokujev Id., Arctic	"(Baer)	"	" "
" lota	Greiphswald	Rudolphi	Rudolphi	1810:43

Gadus merluccius	Rennes, France	Dujardin	Dujardin 1845:617
" morrhua	Warberg	Olsson	Olsson 1867:54
" "	Grand Banks, Newfoundland	Lee	Linton 1890:750
" "	Bergen	Loennberg	Loennberg 1890:23
" pollachius	Rennes	Dujardin	Dujardin 1845:617
" "	Warberg	Olsson	Olsson 1867:54
" "	Bergen	Loennberg	Loennberg 1890:22
" "	Grafverna & Näset, Sweden	Olsson	Olsson 1893:17
" "	Millport, Scotland	Nicoll	Nicoll 1910:355
Lota vulgaris	-----------	Siebold	Baird 1853:89
" "	Memel & Rossitten	Muehling	Muehling 1898:35
" "	Tvärminne Id., Finland	Schneider	Schneider 1903b:8
Morrhua aeglifinus	England	Cobbold	Cobbold 1858:158
" vulgaris	"	"	" " :159
" "	Belgain coast	Beneden	Beneden 1871:56
Merlangus carbonarius	England	Cobbold	Cobbold 1858:159
Merluccius vulgaris	Warberg	Olsson	Olsson 1867:54
Melanogrammus aeglifinus	Woods Hole Region	--------	Sumner, Osborn & Cole 1913:586
Microgadus tomcod	"	--------	" " "
Urophycis tenuis	"	--------	" " "
Melanogrammus aeglifinus	Passamaquoddy Bay, New Bruns.	Cooper	Cooper (the present paper)

Melanogrammus aeglifinus	Bay of Fundy, Campobello Id.	Cooper	Cooper (the prsent paper)
" "	Freepo~~s~~rt,N.S.	"	"
Gadus callarias	Campobello Id.	"	"
" "	Woods Hole	V.N.Edwards	"

One of the most striking features of this species is the presence of a pseudoscolex which is found embedded in the intestinal coeca or intestinal wall of the host, from which it is extracted only by careful dissection. Goeze (1782 : 412, Figs. 1, 4 and 5) described a scolex, somewhat elongated, sagittate and irregular but otherwise quite comparable to that of other bothriocephalids, while Rudolphi (1810 : 43, 44) does not seem to have found anything but such a structure in Gadus lota. Dujardin (1845 : 617) was evidently the first toddescribe the pseudoscolex by saying that, " ... la partie antérieure [of the Strobila] engagee dans l'appendice pylorique forme une sort de bouchon, un cylindre irrégulier, cartilagineux, long de 18mm., large de 4mm., ride on toruleux et sans ancune trace d'organisation ..." This description, however, was not recognized by Diesing (1850 : 590) since he accepted Rudolphi's diagnosis, namely, "Caput subsagittatum, bothriis oblongis lateralibus ...", and Baird (1853 : 89) evidnntly saw two bothria, probably owing to the fact that he was dealing with specimens from Lota vulgaris (vide infra). Cobbold (1858 : 158, 159) was well acquainted with the pseudoscolex, since regarding individuals from the Cod ("Morrhua vulgaris") he said that "In a Cod examined on the 15th of March, 1885, two specimens of Bothriocephalus rugosus had severally attained a length of nearly fifteen inches, and their anterior segments for an inch or more downwards, were so firmly impacted within the pancreatic coeca, that it was found impossible to dislodge them without injuring the filamentary head and neck. As if to make the anchorage doubly sure, the cartilaginous thickening of the invaded pancreatic

coecum had degenerated into a calcareous and contracted cylinder, twisted upon itself in various ways." Olsson (1867 : 54) likewise found a pseudoscolex in this species, which he described as being degenerated in Gadus morrhua to a yellow, elongated mass which disintegrated on contact with water. It was 18-25mm. in length by about ½mm. in diameter, while its position was, as usual, in the wall of a pyloric appendage of the host. He also figured a young strobila from Gadus aeglifinus, the scolex of which he considered to have been invaginated. Van Beneden (1871 : 56) observed the pseudoscolex in his new genus and species, Abothrium gadi, which was afterwards considered to be synonymous with A. rugosum, stating that "Ils ont la tête vers le fond des coecums pyloriques, percent ordinairement les parois et forment, par la gaîne, souvent dure et entortillée comme une tabulaire, une saillie à la surface de cet organe." So far as the writer is aware, he gave the first figure of the structure, as it is commonly met with, encased, however, by the walls of the pyloric coecum in which it was found lodged. Von Linstow (1889 : 242) described and figured a scolex somewhat similar to that of A. crassum, excepting that the apex was hollowed out to form a six-cornered opening which communicated with both bothria. Linton (1890 : 750) found pseudoscolices in examples from the codfish, "Gadus morrhua", which were much as described by Olsson, since "each of the specimens in this lot has the head and anterior part of the body buried in the pyloric caeca, where they have undergone degeneration to such an extent that no appearance of bothria remains. Around the parts thus enveloped by the caeca is a yellowish waxy deposit, the degenerated tissue of the

caeca. This adventitious tissue invested the worm so closely that it would be absolutely impossible for the parasite to free itself from its host." The next important reference to the scolex was by Loennberg (1891 : 75) who, while accepting Van Beneden's new genus, Abothrium, referred the species back to rugosum of Batsch, and described the metamorphosis of the anterior end of the strobila into the well known pseudoscolex, accounting for the various forms, such as figured here. It is noteworthy, however, that he did not state specifically that bothria are present in very young scolices, before this transformation takes place, nor did he give any figures to illustrate the latter. Matz (1892 : 114) described and figured a typical scolex for a specimen 36cm. long from Lota vulgaris, while Schneider (1903a : 9) in delineating a similar structure for the species from the same host, pointed out its great similarity to the scolex of B. proboscideus (= A. crassum). Perhaps of significance in connection with the question of the metamorphosis of the organ is his statement that "Der ganze Scolex kann sich nämlich durch verschiedene Contraction seiner Muskeln in ein pfeilförmiges, oder fast cubisches, oder sogar sichelförmiges Gebilde verwandeln." Later Johnstone (1907 : 170,171) described the pseudoscolex with considerable detail, finding quite the same conditions as did Linton. On account of never meeting with anything like a typical scolex in adult worms he was led to conclude that "Probably in young codling, recently infected, a stage of the cestode with such a scolex might be found but doubtless with increasing age the changes mentioned above occur, and the normal structure of the head disappears." And lastly Scott (1909 : 85) made somewhat similar statements, pointing

out that " ... no satisfactory description of this part of the worm (the pseudoscolex) has yet been published." Thus we see that, apart from Olsson's (1867 : 54) finding in Gadus aeglifinus of a possible young stage in the degeneration of the scolex of this species, no one has, as yet, figured in detail its metamorphosis, Loennberg, however, giving the only description of the process. On the other hand, a typical scolex has been described by several writers, as pointed out above, for what has been taken to be the same species in Lota vulgaris, but since there is evidence that the latter is quite different from the species found in marine Gadidae and since the specimens from Lota maculosa, studied by the writer, were found to belong to the well known A. crassum, we must attribute a pseudoscolex only to adults of A. rugosum, at least until the confusion (vide infra) which exists in the literature regarding the form from Lota can be cleaned up by further investigation.

Two forms of scolex which were dissected out by the writer from the pyloric cocca of Melanogrammus aeglifinus, the Haddock, and Gadus callarias, the Cod, as shown in Figs. 87 and 88, respectively, the latter being from the largest specimen at hand, while what is doubtless a younger stage in the degeneration of the scolex is shown in Fig. 86 from the intestine of a Haddock. A series of transverse sections of this one, brought out that the internal anatomy was quite suggestive of a typical scolex, that of A. crassum for example. As shown in the figure, the structure is somewhat flattendd; and this flattening was found to be a dorsoventral one. While there were only faint suggestions of bothria, especially

towards the tip, the arrangement of the muscles, nerves and excretory vessels pointed to this being possibly not far removed from the typical form of scolex; and this view is supported by the facts that it was found free in the anterior part of the intestine of the Haddock, altho, unfortunately, the length of the strobila was not recorded. Among a lot of material taken from several Haddock two examples of the scolex, as it would seem to be at or about the time degeneration sets in, were found. The first one, shown in Fig. 84, was from the smallest strobila at hand, 22mm. in length, while the other, Fig. 85, from an older chain only the anterior end of which was present with a length of 32mm. and maximum breadth of 2.5. As indicated, the second is evidently the older from the standpoint of the metamorphosis, since it is more conical and less separated from the neck region which is slightly swollen, while the bothria are disappearing as the whole structure is approaching the stage represented by Fig. 86. In Fig. 84 are seen somewhat more efficient bothria, but the shape of the organ points to a considerable amount of degeneration having already taken place. The second form of scolex is shown in Fig. 87. Here the structure is likewise not embedded in the wall of the pyloric caecum in which it is found but free in its lumen, the anchorage for the strobila being obtained by the close approximation of the mouth of the caecum around the narrow neck region and the concomitant swelling of the more distal portions. Furthermore, the indications are that a considerable portion of the anterior end of the strobila is involved in the formation of the organ, especially since it is comparatively large. The third form observed is shown in Fig. 88, where degenr-

ation has gone on to such an extent that there remains only a filamentous, horny or cartilaginous yellow mass, deeply imbedded in the wall of the caecum, from which it was dissected with considerable difficulty. Only the tip is shown, there having been about 6mm. more to the region where it left the host tissues and passed insensibly on to the anterior portion proper of the strobila, which latter showed only faint transverse wrinkles and no distinct division into segments, as is seen, with some irregularity, however, in Fig. 87. This form of pseudoscolex was found, as described by Olsson, Linton and Johnstone, to be surrounded by the tissue of the coecum degenerated to a yellow waxy mass which, when freed from the surrounding tough tissue, crumbled easily under the dissecting instruments. The comparatively great extent of the organ longitudinally in the wall of the host's pyloric coecum, as the measurement indicates, need not be emphasized if one has ever endeavored to dissect it out entire!

As stated above there is considerable evidence in the literature of this species to indicate that the form found in marine Gadidae and called _A. gadi_ by van Beneden (1871 : 56) is not the same as that found in the only fresh-water gadid, viz., _Lota_. In endeavoring to place a number of specimens from _Lota maculosa_, it was found that in many points they agreed with the description given by Matz for _A. rugosum_. The scolices are more or less alike, no pseudoscolex (see below, however) being present; the longitudinal muscles are not in bundles; the nerve strands are dorsal to the cirrus and vagina; the genital cloacae are irregularly alternating from side to side; the vagina opens ahead of the cirrus instead of

behind; the testes are continuous from proglottis to proglottis; the vitelline follicles are located among the longitudinal muscles and are discontinuous; and the uterus-sacs are rounded laterally; of which characters, however, the position of the nerve strands and the alternation of the cloacae are applicable to the material from the marine Gadidae studied. In many more points, on the other hand, the species agreed with A. crassum, so that the writer was obliged to consider it to belong to that species. A comparison of Matz's description with that of Loennberg brings out many differences. Loennberg described a pseudoscolex, calcareous bodies, the longitudinal muscles in bundles, the other sets of parenchymatous muscles as above described, the vagina opening behind the cirrus and ventrally, testes discontinuous, vitelline follicles within the parenchymatous muscle-sack and also discontinuous, none of which characters are to be found in Matz's description, but all of which are present in the material at hand from marine Gadidae. It is to be noted here that Loennberg accepted the specific name rugosum of Rudolphi instead of the gadi of van Beneden, which as will be seen presently may not be admissable. Going back, then, to the only other and the earliest description of the anatomy of the species that of Linstow (1889 : 243-5), we meet with similar difficulties and confusion. Linstow gave as hosts for the species, which he called B. rogosus Rud., Gadus aeglifinus, G. morrua, Merlangus carbonarius, M. pollachius, Merlucius vulgaris, Lota vulgaris, L. molva and Motella mustela. Charact rs in his description not applicable to the material studied were: No pseudoscolex, but scolex of a rather peculiar shape and structure terminally (vide supra);

nerve strand 56 μ in diameter; 10 excretory vessels anteriorly arranged in two groups of five each; genital cloacae unilateral, between the middle and hinder thirds of the edge of the proglottis; vagina opening ahead of the cirrus; length of cirrus-sac 0.42mm. (!); ovary 0.14 x 0.12mm.; uterus spherical when obviously young; and eggs 59 x 43 μ. Testes with a dimmeter of 60 μ, vagina 16-36 μ. in diameter at the beginning, and two vitelline ducts, besides a few other minor points in the general anatomy, agree, however, with the species as studied by the writer. Thus we see that there is by no means anything like complete agreement as regards details among the three descriptions by Linstow, Loennberg and Matz. But this does not seem to have inconvenienced many of the writers since then, notably Ariola (1900 : 432) and even Luehe (1900a) whose references to the position of the vitelline follicles and the ventral bow in the vagina are at variance with conditions found here; altho Johnstone (1907), Scott (1909) and Nicoll (1910) were obviously dealing with the form described by Loennberg. Schneider (1903a : 7-10) seems to have been the only one who pointed out the differences between the form from Lota and that from marine Gadidae. He said: "Bothriotaenia rugosa gleicht sowohl in ihrem Aussehen, als auch in ihrer Anheftungsweise ausserordentlich der Species B. proboscidea, die in unseren Lachsen (Salmo salar) so massenhaft vorkommt. Trotzdem pflegt man aber seit Rudolphi, soviel mir bekannt, immer die in Lota meist vorkommende Form als eine getrennte Species aufzufassen unter dem Namen "rugosa" (Bothriocephalus rugosus Rud. = Dibothrium rugosum Diesing u.s.w.), obgleich die unterscheidenden Merkmale zwischen B. proboscidea und

B. rugosa, die Riggenbach in seinen "Bemerkungen ueber das Genus Bothriotaenia Railliet" übersichtlich zusammenstellt, recht unbedeutend sind und vielleicht doch noch im Rahmen der Variationsbreite einer einzigen Species untergebracht werden können;" and, as regards the latter, in a footnote: "Die von M. Luehe ... als Unterscheidungsmerkmal vorgeschlagene Lage der Dotterstöcke zum Theil (B. rugosa), bzw. auschliesslich (B. proboscidea) zwischen den Längsmuskeln, scheint mir auch nicht genugend constant zu sein, um als Speciesmerkmal verwandt werden zu können." For material from Lota vulgaris Schneider described a scolex and segments both similar, as he pointed out, to those of B. proboscidea (= A. crassum). The arrangement of the genital cloacae, irregularly alternating but unilateral for long stretches, the openings of the uteri in a longitudinal furrow, the early form of the uterus-sac and the size of the eggs (64.5μ x 50-52μ), as described by the same worker all agree with A.crassum as studied by the writer (cf. infra). In conclusion Schneider said: "Uebrigens habe ich, wie gesagt, auch an die Examplaren aus dem Museum keine Pseudoscolexbildung bemerkt und zweifle daran, dass B. rugosa und B. gadi ein und dieselbe Art sind" and further, "Es ist mir übrigens bisher noch nicht gelungen, B. rugosa oder B. gadi in Gadus morrhua des Finnischen Meerbusens aufzufinden, obgleich ich zahlreiche Exemplare des Dorsches seciert habe, und obgleich B. rugosa in Lota vulgaris hier oft genug vorkommt. Auch das scheint gegen die Identität der Species B. rugosa mit B. gadi zu sprechen."

Thus we see that there is considerable detailed evidence thtt the species from Lota is not the same as that from the marine

hosts. We must then go back of Linstow's time in order to determine, if possible, what is the correct name for the latter. Next in retrogressive order is van Beneden's (1871 : 56) description of A. gadi, confined to a short footnote which deals with little more than the pseudoscolex. So far as it goes this agrees with Loennberg's A. rugosum and with the material studied by the writer. Olsson (1867 : 34) was obviously dealing with the same form which he reported from marine hosts only. Diesing (1863 and 1850) copied from Rudolphi while Cobbold (1858) had the marine form before him, and Baird (1853) had the fresh-water form. In spite of Linstow's objection the writer feels certain that Dujardin (1845) also had the species dealt with here, especially since his measurements of the eggs come nearest to those observed than to those of any other writer. It remains then to enquire into Rudolphi's finding and description, Leuckart (1819 : 57) copying from him altho at the same time remarking that "Ist am nächsten mit den B. proboscideus verwandt, und, wenn er nicht eine Art mit diesem ausmacht zwischen B. proboscideusund B. sagittatus zustellen." For B. rogosus Rudolphi (1810 : 42-43) described a scolex, quite comparable to that of his B. proboscideus and to Linstow's description and figure of the organ, no neck and segments "primi angusti, fere quadrati, insequentes latitudinis ratione habita brevissimi, saepeque inequales, vel hinc inde angustiores; marginès obtusi crassiusculi." This with "neque ovaria, neque foramina articulorum vidi ... " and the further fact that he obtained his specimens from Gadus lota (= Lota vulgaris), leads the writer to believe that he was not dealing with the form present in marine hosts but with a form

which, if not identical with A. crassum, -- his B. infundibuliformis and B. proboscidens, -- was very close to it. We must then go back farther to Batsch (1786 : 208-9) where the species, T. rugosa was named on the basis of Goeze's (1782 : 410) description of "Der runzlichter Fischbandwurm" from Gadus mustela (= Motella mustela), the marine five-brearded Rockling of Europe, which the latter called T. tetragonoceps Pallas with some doubts, however, as discussed under the next species dealt with here. Batsch gave the following diagnosis of T. rugosa:

> "Taenia (larvata)capite cnnico cum corpore subconfluente, papillis lateraliter adnatis usque ad apicem capitis, eisque binis: articulis brevissimis, dilatatis, corpore serrato."

He used Goeze's Figs. 1-4 and pointed out that he (Goeze) recognized differences between his specimens and Pallas' T. tetragonoceps, for "Er rechnet beyde Würmer fur eine Art, und die Glieder nebst dem ganzen Korper haben viel Gleichheit, auch die äussere Gestalt des Kopfs. Doch sind bey diesem letztern die Saugblasen bey weiten nicht so deutlich gezeichnet, und stellen vielmehr, wie sich Götze ausdrückt, zwey Backenbarte vor. Die Furche auf dem Korper ist auch vorhanden, nur scheint der Korper mehr gestreckt, und am Rande mehr zackig zu seyn." Consequently the correct name of the species depends on whether we consider Goeze's description, augmented by Batsch's contributions, to be applicable to the material at hand. The largest of Goeze's specimens measured in warm water a yard and a half in length by scarcely one-half a line in breadth; but the latter is decidedly at variance with his Figs.

1 and 2 which he said were drawn in "natürlicher Grösse", in which case the width would be from 7 to 15 lines and the scolex about 1?.5 lines (6mm.) in length! For such large specimens, -- even tho we consider only the first set of measurements, -- he described and figured nothing of diagnostic value other than a scolex provided with two bothria pretty much of the ordinary type, behind this a "distinctly jointed" and "almost cylindrical" neck and along both surfaces of the posterior closely crowded segments a median longitudinal furrow, all of which characters more nearly agree with the proboscideum type of A. crassum (vide infra) rather than with the A. rugosum described above. And since the latter is clearly not T. tetragonoceps Pallas as described by Batsch (l.c.: 204-208), the only course that seems open to the writer is to refer the species to van Beneden's Abothrium gadi. However, in view of the fact that no material from the European ling (Lota vulgaris) was available for a comparative study, he does not feel justified in taking this step, but here retains at least tentatively the specific name Abothrium rugosum (Batsch, 1786) (nec A. rugosum Goeze, 1782).

The material studied consisted of seven lots from Melanogrammus aeglifinus, and one from Gadus callarias, from the writer's Collection; and one lot from the latter host from Coll. Univ, Ill.

Species 2. Abothrium crassum (Bloch, 1779)
(Figs. 93 –106.)

1779	Taenia crassa	Bloch	1779 : 545
1780	Taenia salmonis	Mueller	1780 : 179,202
1781	Taenia tetragonoceps (part.)	Pallas	1781 : 87
1782	Taenia capite truncato	Bloch	1782 : 15
1782	"Der runzlichter Fischbandwurm"	Goeze	1782 : 410
1782	Taenia proboscis suilla	Goeze	1782 : 417
1786	Taenia tetragonoceps	Batsch	1786 : 204
1786	Taenia proboscidea	Batsch	1786 : 212
1790	Taenia salmonis	Gmelin	1790 : 3080
1790	Taenia salvelini	Schrank	1790 : 125
1793	Taenia salvelini	Schrank	1793 : 141
1795	Taenia salmonis	Rudolphi	1795 : 17
1802	Taenia salmonis	Bosc	1802 : 308
1802	Taenia proboscidea	Rudolphi	1802 : 106
1803	Rhytis salvelini	Zeder	1803 : 292
1810	Bothriocephalus proboscidea	Rudolphi	1810 : 39
1810	Bothrioc. infundibuliformis	Rudolphi	1810 : 46
1816	Bothrioc. proboscidea	Lamarck	1816 : 582
1819	Bothrioc. proboscidea	Rudolphi	1819 : 137,472
1819	Bothrioc. infundibuliformis	Rudolphi	1819 : 137,473
1819	Bothrioc. proboscidea	Leuckart	1819 : 38
1819	Bothrioc. infundibuliformis	Leuckart	1819 : 42

1843	Bothrioc. salmonis umblae	Koelliker	1843 : 91
1844	Bothrioc. proboscideus	Bellingham	1844 : 252
1844	Bothrioc. infundibuliformis	Belliggham	1844 : 253
1845	Bothrioc. proboscideus	Dujardin	1845 : 615
1845	Bothrioc. infundibuliformis	Dujardin	1845 : 616
1846	"Bothriocephalus du Saumon"	Blanchard	1847 : 116
1850	Dibothrium proboscideum	Diesing	1850 : 590
1850	Dibothrium infundibuliforme	Diesing	1850 : 590
1853	Bothrioc. proboscideus	Baird	1853 : 88
1853	Bothrioc. infundibuliformis	Baird	1853 : 88
1863	Dibothrium proboscideum	Diesing	1863 : 242
1863	Dibothrium infundibuliforme	Diesing	1863 : 242
1867	Bothrioc. proboscideus	Olsson	1867 : 53
1871	Bothrioc. proboscideus	Beneden	1871 : 69
1878	Bothrioc. infundibuliformis	Linstow	1878 : 263
1884	Bothrioc. infundibuliformis	Zschokke	1884 : 21
1889	Bothrioc. suecicus	Loennberg	1889 : 35
1892	Bothrioc. infundibuliformis	Matz	1892 : 110
1893	Bothrioc. infundibuliformis	Olsson	1893 : 17
1893	Bothrioc. proboscideus	Olsson	1893 : 17
1894	Bothriotaenia infundibuliformis	Blanchard	1894 : 701
1896	Bothriot. infundibuliformis	Ariola	1896 : 280
1896	Bothriot. infundibuliformis	Riggenbach	1896 : 223
1899	Abothrium crassum	Luehe	1899 : 39

1900	Bothriot. proboscidea	Ariola	1900 : 433
1900	Abothrium crassum	Luehe	1900a: 97
1909	Bothrioc. proboscideus	Scott	1909 : 78
1910	Abothrium crassum	Luehe	1910 : 26
1910	Abothrium crassum	Ward	1910 : 1184

Specific diagnosis: With the characters of the genus. Large cestodes with maximum length, breadth and thickness of 870, 6 and 2mm.,respectively. Scolex variously shaped; usually rounded posteriorly and truncated anteriorly; with prominent bothria and terminal disc. First segment may or may not be elogated to form a short neck. Proglottides at first broad and short or more quadrate, cuneate or infundibuliform in shape; then, in the middle of the strobila, five or more times broader than long; and finally posteriorly quadrate or as long as broad. Usually a median longitudinal groove down each surface of the strobila formed by emarginations on the posterior borders of the segments.

Cuticula 4 to 5 μ thick, subcuticula 60 to 100 μ. Calcareous bodies (?) absent in adult strobilas. Longitudinal muscles not in bundles; no muscular septa between proglottides. Nerve strands 40 μ in diameter, dorsal to inner end of cirrus-sac. 12 chief excretory vessels, 6 on each surface just within the transverse muscles, reduced to 6 or 8 anteriorly.

Genital cloaca irregularly alternating, but unilateral for long stretches; from one-third to one-half way along the margin

of the proglottis. Vagina opens ahead of and slightly ventral to the cirrus; no distinct hermaphroditic duct.

Testes within the nerve strands, pseudostratified, continuous from joint to joint; elongated dorsoventrally, 95-115 x 70-100μ; 40 to 150 in number. Vas deferens lateral, elongated, with few coils before entering the cirrus-sac, 350-600 x 150-180μ in dimensions. Cirrus-sac ovoid with narrow end outward, 130-380 x 60-150μ Cirrus proper an almost straight tube in outer half of sac.

Ovary comparatively small, irregular or somewhat lobed, with thick isthmus, o.8mm. wide by 0.13 long. Oocapt 40μ in diameter. Usually two ventral vitelline ducts unite to form a common duct which does not act as a reservoir. Vitelline follicles irregular in shape and size, among the longitudinal muscles or outside of them, discontinuous. Shell-gland small, compact, dorsal. Uterine duct with only a few coils near the median line. Uterus-sac transversely elliptical or quadrate and somewhat lobed, rounded laterally, filling up almost the entire proglottis when gravid; opening in the median line opposite emarginations of segments.

Eggs, 45-115 x 30-75μ, ovoid or ellipsoid in shape.

Habitat: In the pyloric coeca and intestine of the host.

Host	Locality	Collector	Authority
Salmo salar	----------	Borke	Goeze 1782:417
" "	----------	Batsch	Stiles and Hassall 1912:395
" "	----------	Rudolphi	" " "

Salmo salar	----------	Zeder	Stiles & Hassall	1912:395
" "	----------	Rudolphi	Rudolphi	1810:40
" "	Gryphswald	"	"	1819:137
" "	Ireland	Bellingham	Bellingham	1844:253
" "	Paris	Dujardin	Dujardin	1845:615
" "	----------	M.C.V.	Diesing	1850:590
" "	----------	Siebold & Johnston (Coll.Brit. Mus.)	Baird	1853:88
" "	Warberg	Olsson	Olsson	1867:53
" "	Belgian coast	Beneden	Beneden	1871:69
" "	Warnemünde	Zschokke	Braun	1891:55
" "	Näset	Olsson	Olsson	1893:17
" "	Rhine R.,Basel	Zschokke	Zschokke	1896:776
Salmo salar nobilis	Murman-Küste	Zool.Mus. Kais.Akad. Wiss.,Petrograd	Linstow	1903:20
Salmo salar sebago	Lake Sebago,Me.	Ward	Ward	1910:11 (84
Salmo alpinus	----------	Mus.Vienn.	Rudolphi	1819:137
" "	Jemtland	Olsson	Olsson	1876:149
" "	Lakes Nackten, Störsjön,Lock-nesjön	"	"	1893:17
" carpio	L.Garda,Italy	Ninni	Stossich	1890:7
" caspius	Karabugas-Strasse	Maximovic	Linstow	1903:20
" fario	Ireland	Bellingham	Bellingham	1844:252

	Salmo fario	Rome	Condorelli	Ariola	1900:435
	" "	Vyg-Fluss	Danilevskij	Linstow	1903:20
	" hucho	----------	Mus.Vienn.& Bremser	Rudolphi	1819:472
	" "	***-------	Diesing	Diesing	1850:590
	" lacustris	Benacò	Largaiolli	Ariola	1900:435
	" Namaycush	Shoal Id.,Lake Superior	Milner	"	" "
	" salvelinus	----------	Schrank	Stiles & Hassall	1912:402
	" "	----------	Zeder	"	" :303
	" "	----------	Mus.Vienn.	Rudolphi	1819:137
	" "	----------	Diesing	Diesing	1850:591
	" siscowet	Outer Id.,Lake Superior	Milner	Ariola	1900:435
?	" thymallus	----------	Coll.Vienn.	Leuckart	1819:43
	" " vexillifer	--------	M.C.V.	Diesing	1850:591
	" trutta	Ireland	Bellingham	Bellingham	1844:253
	" "	----------	Coll.Brit. Mus.	Baird	1853:88
	" "	Lakes Störsjön, Hålen,Refunds-sjon,Sällsjön,& Ockesjön,Jemtland	Olsson	Olsson	1893:17
	" "	Murman-Küste	Zool.Mus.d. Kais.Akad. Wiss.,Petrograd	Linstow	1910:281
	" umbla	----------	M.C.V.	Diesing	1850:591
	" "	----------	Zschokke	Zschokke	1884:21

Coregonus fera	----------	Zschokke	Zschokke	1884:21
" lavaretus	Lakes Störsjön, and Nälden	Olsson	Olsson	1893:17
" oxyrhynchus maraena	Warberg	Olsson	Olsson	1867:53
Trutta fario	Genfersee,Basel	Zschokke	Zschokke	1896:776
" lacustris	Rhine R.,Basel	"	"	" "
" "	Bodensee	Hofer	Hofer	1904:221
" salar	East Prussia	Muehling	Muehling	1898:35
" trutta	Warnemünde	Zschokke	Braun	1891:55
" variabilis	----------	"	Zschokke	1884:21
Thymallus vulgaris	----------	"	"	" "
" "	Störsjön,Jemtland	Olsson	Olsson	1893:17
" "	Baikal-See	Zool.Mus.d. Kais.Akad. Wiss.,Petrograd	Linstow	1903:20
Esox lucius	----------	Zschokke	Zschokke	1884:21
Perca fluviatilis	----------	"	"	" "
Osmerus eperlanus	Bönan,Gestricia,Gulf of Bothnia	Olsson	Olsson	1893:17
Clupea harengus	Ostsee	Schneider	Schneider	1902:28
Lota vulgaris	Störsjön,Jemtland	Olsson	Olsson	1893:17
" "	Dvina-Fluss	Danilevskij	Linstow	1903:20
"Trout"	Loch Tay	Williamson	Scott	1909:78
Cristivomer namay-cush	Id.,Georgian [illegible]	Cooper	(the present paper) Cooper	

Cristivomer namaycush	Port Credit, Ont., Lake Ontario	Cooper	Cooper (the present paper)
" "	L. Temagami, Ont.	H.B.Ward	"
" "	Charlevoix, Mich.	"	"
" "	Pentwater, Mich.	"	"
"Lota lota"	Charlevoix	"	"
Lota maculosa	Port Credit	Cooper	"
Coregonus clupeiformis	Giant's Tomb Island	"	"

This species, originally given the specific name of *Taenia crassa* by Bloch (1779 : 545), was on the one hand confused with *A. rugosum* and on the other given the new name *Taenia proboscis suilla* by Goeze (1782 : 410-11, 417, resp.) according as it was found in *Gadus* or in *Salmo salar*, which confusion was evidently due to the fact that the latter followed Pallas (1781) in calling it *T. tetraganoceps*. In a footnote he considered, in fact, that *T. tetragonoceps* Pallas, *Taenia crassa* Bloch and *T. capite truncato* Bloch were all synonymous. But in spite of this he expressed doubt on the synonymy of the forms from the Gadidae and from the Salmonidae. As the above synonymy indicates the species was then known for a number of years under at least two names, *Bothriocephalus infundibuliformis* and *B. proboscideus* which were used by Rudolphi (1810 : 46, 39) for the two forms from freshwater and marine salmonids in general. It was not until 1884 that Zschokke made a detailed comparison, -- it is true of external characters mostly, -- of the two species from a number of different hosts, and showed that they must be considered only different forms of the same species. Later investigations into the anatomy by Matz (1892 : 110), who, however, studied only the *proboscideus* form from *Trutta trutta* and *Salmo salar*, have been considered to have established this contention, altho Olsson (1893 : 17) still reported both of the older species with some doubt as to the use of the name *B. infundibuliformis*. Blanchard (1894 : 701), Ariola (1896 : 280) and Riggenbach (1896 : 223) evidently accepted only the latter specific name, while Luehe (1899 : 39) first used the combination *Abothrium crassum* (Bloch) which is now generally accepted. Ariola (1900 :

433), it might be mentioned finally, called the species (Bothriotaenia proboscidea (Batsch), thus disregarding the fact that Batsch (1786 : 212) renamed Bloch's T. crassa.

As regards the scolex, various forms of which are shown in the figures, the specimens from Lota maculosa, the common Ling or Burbot, need special mention, since, as shown in Fig. 98, the terminal disc and anterior half of the organ is in many instances greatly swollen to form a sort of pseudoscolex which is perhaps well adapted to maintaining its position in the narrow pyloric caecum of the host. But this modification was found only in the older strobilas of the four lots examined. In the younger chains the scolex is as shown in Figs. 96 and 97 which are drawn to the same scale as that of Fig. 98. The largest with this first form of scolex was 23mm. in length by 1.5 in breadth while the shortest with the swollen end was 45 x 1.5mm., so that somewhere between the lengths of 20 and 45mm. the metamorphosis takes place in all probability. No distinct intermediate stages were seen altho the smaller scolices were varied in shape and degree of intactness. The latter might seem to point to the condition being due to mechanical or physical means, but this is offset by the fact that the material was found to be in good histological condition when sectioned; hence the idea of a possible metamorphosis. Unfortunately the material did not permit of anything more to be said on this matter.

In the anterior segments of considerably relaxed or especially young strobilas something of the manner of segmentation can be seen. This was found to take place much as in the genus

Bothriocephalus, altho the writer was not able to distinguish the primary segments to his satisfaction. What was considered to be such is shown in Fig. 99, a stretch of segments beginning 27mm. from the anterior end of the strobila in question. The idea of dominence of the anterior portions over the posterior portions, as dealt with under *B. scorpii*, is here brought out very nicely. In the *proboscideus* type of strobila the same method of subdivision was followed in the anterior segments, altho with greater difficulty on account of the fact that the segments are so closely crowded together longitudinally. Olsson (1867 : 53) noticed the subdivision of the segments producing an alternation of larger and smaller ones, but he considered it to be an *articulatio spuria* similar to that described by Wagener (1851 : 69) for *Amphicotyle heteropleurum* and by Krabbe (1865 : 37) for *B. scorpii* and other species. Later Olsson (1893 : 17) stated that transverse divisions occurred in *B. infundibuliformis* as well as in *B. proboscideus*.

The youngest lots of material, studied by the writer were two taken from *Lota maculosa* from Lake Ontario, off Port Credit, Ontario, and one from the intestine of a young *Cristivomer namaycush* from the same locality. The lot from the Lake Front contained all stages from that shown in Figs. 104 to the largest which by comparison with adult specimens from the same host were found to belong to this species. While no stages were found between that shown in Fig. 104 and that in Fig. 102, -- altho two others were only slightly larger than the latter, -- it seems reasonable to consider the latter itself to belong to this series and to represent the earliest stage of the same. Figs. 105 and 106,

of two later stages, are given to show the manner of beginning of the segmentation and the early dropping off of two or more very immature segments from the posterior end. The first indications of this is probably represented in Fig. 104, altho the strobila in Fig. 105 does not show it. The relative ages, however, of these two is difficult to state definitely since the first one is more contracted longitudinally than the other. On the other hand, two, intermediate in length between those shown in Figs. 105 and 106, were indented posteriorly, thus showing that some of the earliest segments had already been lost. Thus we see that at a very early period in the development of the strobila of this species a few of the first formed segments are lost in much the same way as the bladder of the cysticercous of the taenioid cestodes is cast off in the final host.

The material studied consisted of five lots from *Salmo salar*, eleven from *Cristivomer namaycush*, two from *Coregonus clupeiformis*, and two from *Lota maculosa*, all from the writers collection; and, eight lots from *C. namaycush*, and two from *L. maculosa* from the Collection of the University of Illinois.

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EXPLANATION OF PLATE I.

Fig. 1. Ligula intestinalis, scolex of larva.

Fig. 2. " " , anterior end of adult.

Fig. 3. " " , median portion of a transection thru the genital cloaca.

Fig. 4. Ligula intestinalis, union of vagina, oviduct and vitelline duct.

Fig. 6. Ligula intestinalis, toto of larva from Micropterus dolomieu.

Fig. 7. Schistocephalus solidus, anterior end of larva.

Fig. 8. " " , median portion of transection thru the ovary.

Fig. 9. Schistocephalus solidus, median portion of transection thru the seminal vesicle and cirrus-sac.

EXPLANATION OF PLATE II.

Fig. 5. Ligula intestinalis, larva from liver of Gasterosteus bispinosus.

Fig.10. Haplobothrium globuliforme, outline of smallest larva at hand.

Fig.11. Haplobothrium globuliforme, scolex, toto.

Fig.12. " " , primary strobila, toto.

Fig.13. " " , secondary scolex, surficial view.

Fig.14. Haplobothrium glubuliforme, same, lateral view.

Fig.15. " " , transection thru scolex.

Fig.16. " " , the ganglionic mass.

Fig.17. " " , transection thru proboscis bulb.

Fig.18. Cyathocephalus americanus, scolex, toto.

EXPLANATION OF PLATE III.

Fig. 19. Cyathocephalus americanus, transection thru ovarian isthmus.

Fig. 20. Cyathocephalus americanus, diagram of medial sagittal section.

Fig. 21. Cyathocephalus americanus, frontal section of ripe proglottis.

Fig. 22. Cyathocephalus americanus, oocapt containing an ovum.

Fig. 23. Marsipometra hastata, scolex, surficial view.

Fig. 24. " " , same, lateral view.

Fig. 25. " " , transection thru ovarian isthmus.

Fig. 26. " " , toto of ripe proglottis.

Fig. 27. " " , genital cloaca from frontal section.

Fig. 28. " " , cirrus-sac from a transection.

Fig. 29. " " , larva.

Fig. 30. " " , older larva.

EXPLANATION OF PLATE IV.

Fig. 31. Triaenophorus, larva, robustus type, surficial view.

Fig. 32. " , same, lateral view.

Fig. 33. " , same, one of the tridents of hooks.

Fig. 34. " ? larva, nodulosus type, surficial view.

Fig. 35. " , same lateral view.

Fig. 36. " , same, a trident, end view.

Fig. 37. " , same, surficial view.

Fig. 38. Bothriocephalus scorpii, scolex, surficial view.

Fig. 39. " " , same, lateral view.

Fig. 40. " " , three anterior primary segments,

Fig. 41. " " , one farther back, also toto.

Fig. 42. " " , another showing reproductive rudiments, toto.

Fig. 43. Bothriocephalus scorpii, transection thru ovary.

Eig. 44. " " , portion of strobila showing excretory vessels.

Fig. 45. Bothriocephalus scorpii, outline of mature segments.

EXPLANATION OF PLATE V.

Fig. 46. Bothriocephalus scorpii, toto of mature proglottides.

Fig. 47. " " , median sagittal section composite.

Fig. 48. Bothriocephalus scorpii, toto of two segments.

Fig. 49. " " , portion of section showing union of vagina with oviduct.

Fig 50. B. claviceps, from Eupomotis gibbosus, scolex, surficial view.

Fig. 51. B. claviceps, same, lateral view.

Fig. 52, " " , from Anguilla rostrata, scolex, surficial view.

Fig. 53. B. claviceps, from Eup. gibbosus, transection thru ovary.

Fig. 54. " " , same, toto of mature proglottides.

Fig. 55. " " , same, median sagittal section.

EXPLANATION OF PLATE VI.

Fig. 56. B. cuspidatus, scolex, surficial view.

Fig. 57. " " , same, lateral view.

Fig. 58, " " , transection thru an anterior segment.

Fig. 59. " " , transection thru ovary of mature proglottis.

Fig. 60. " " , toto of ripe proglottides, posterior in deeper optical section.

Fig. 61. B. cuspidatus, median sagittal section , composite.

Fig. 62. " " , young egg, showing an early stage in development.

Fig. 63, B. cuspidatus, oleder egg, many celled stage.

EXPLANATION OF PLATE VII.

Fig. 64. _B_. _manubriformis_, scolex, surficial view.

Fig. 65. " " , same, lateral view.

Fig. 66. " " , anterior primary segment.

Fig. 67. " " , transection thru anterior region.

Fig. 68. " " , toto of mature proglottides.

Fig. 69. " " , cirrus-sac and vaginal bulb ih transection.

Fig. 70. _B_. _manubriformis_, transection thru uterus opening.

Fig. 71. _B_. _occidentalis_, scolex, after Linton.

Fig. 72. " " , cirrus-sac in a transection.

Fig. 73. _Clestobothrium_ _crassiceps_, scolex, surficial view.

Fig. 74. " " , same,lateral view.

Fig. 75. " " , same, terminal view.

Fig. 76. " " , toto of scolex and anterior end

EXPLANATION OF PLATE VIII.

Fig. 77. C. crassiceps, toto of young strobila.

Fig. 78. " " , primary segment with reproductive rudiments, toto.

Fig. 79. C. crassiceps, segments showing spurious articulations.

Fig. 80. " " , transection thru ovary.

Fig. 81. " " , toto of mature proglottis.

Fig. 82. " " , median sagittal section, composite.

Fig. 83. " " , four consecutive sections thru union of vagina and oviduct, showing the receptaculum seminis.

Fig. 84. Abothrium rugosum, scolex of young strobila.

Fig. 85. " " , later stage in degeneration of same.

Fig. 86. " " , still later stage.

EXPLANATION OF PLATE IX.

Fig. 87. Abothrium rugosum, pseudoscolex from lumen of pyloric coecum of host.

Fig. 88. Abothrium rugosum, pseudoscolex imbedded in wall of coecum.

Fig. 89. Abothrium rugosum, transection thru ovary.

Fig. 90. " " , terminal excretory vesicle.

Fig. 91. " " , frontal section of mature proglottis.

Fig. 92. " " , union of vagina and common vitelline duct with oviduct.

Fig. 93. Abothrium crassum, scolex of specimen from Salmo salar, surficial view.

Fig. 94. Abothrium crassum, same,lateral view.

Fig. 95. " " , scolex from Cristivomer namaycush.

Fig. 96. " " , scolex from Lota maculosa.

Fig. 97. " " ; same, lateral view.

EXPLANATION OF PLATE X.

Fig. 98. <u>Abothrium crassum</u>, enlarged scolex from <u>Lota maculosa</u>.

Fig. 99. " " , anterior segments of strobila from <u>Coregonus clupeiformis</u>, toto.

Fig. 100. <u>Abothrium crassum</u>, transection thru ovary of specimen from <u>Salmo salar</u>.

Fig. 101. <u>Abothrium crassum</u>, toto of ripe proglottis of chain from <u>C. clupeiformis</u>.

Fig. 102. <u>Abothrium crassum</u>, plerocercoid from <u>C. namaycush</u>, superficial view.

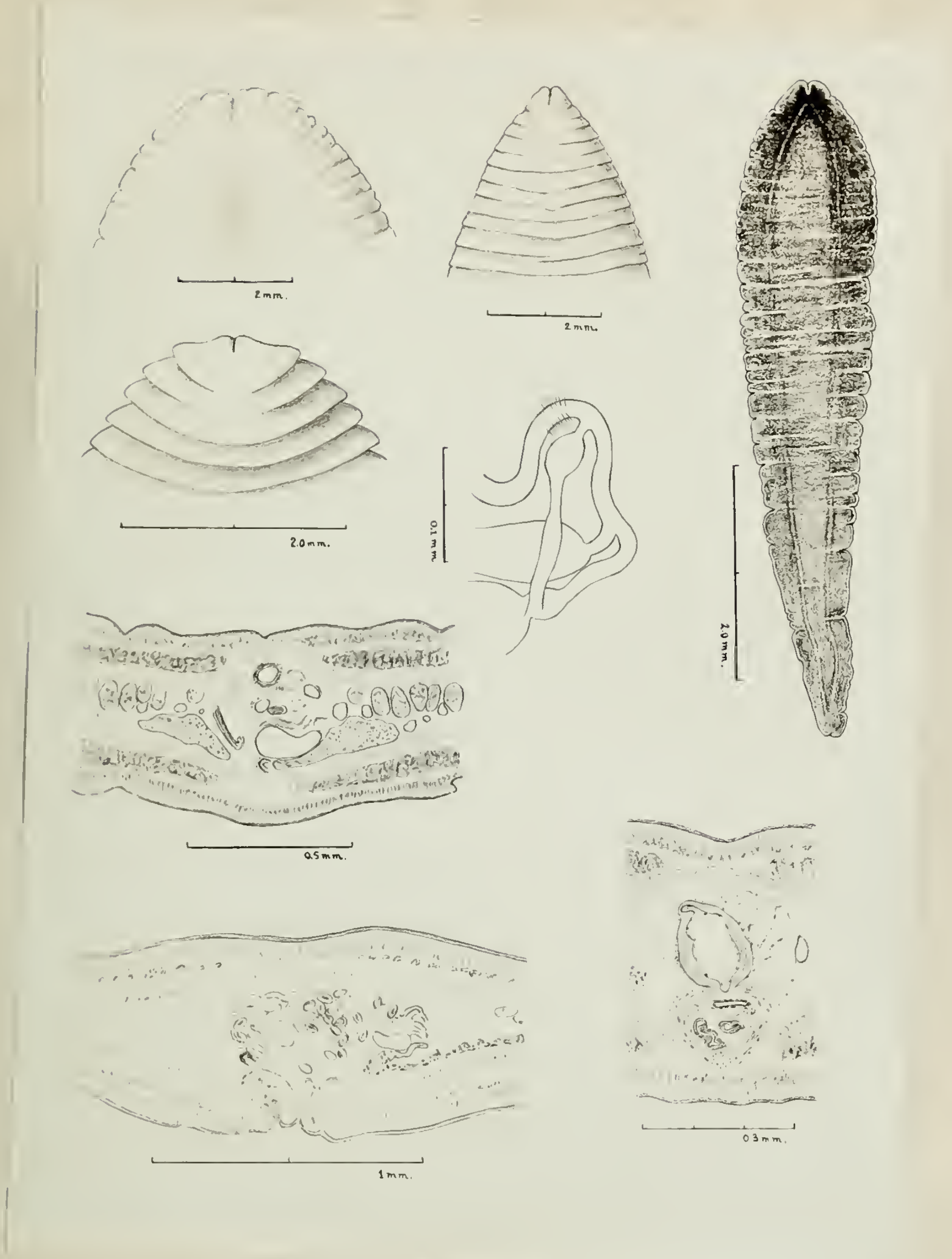
Fig. 103. <u>Abothrium crassum</u>, same lateral view.

Fig. 104. " " , young strobila from same host.

Fig. 105. " " , older strobila from same host.

Fig. 106. " " , still older strobila, showing dropping off of segments posteriorly.

PLATE I.



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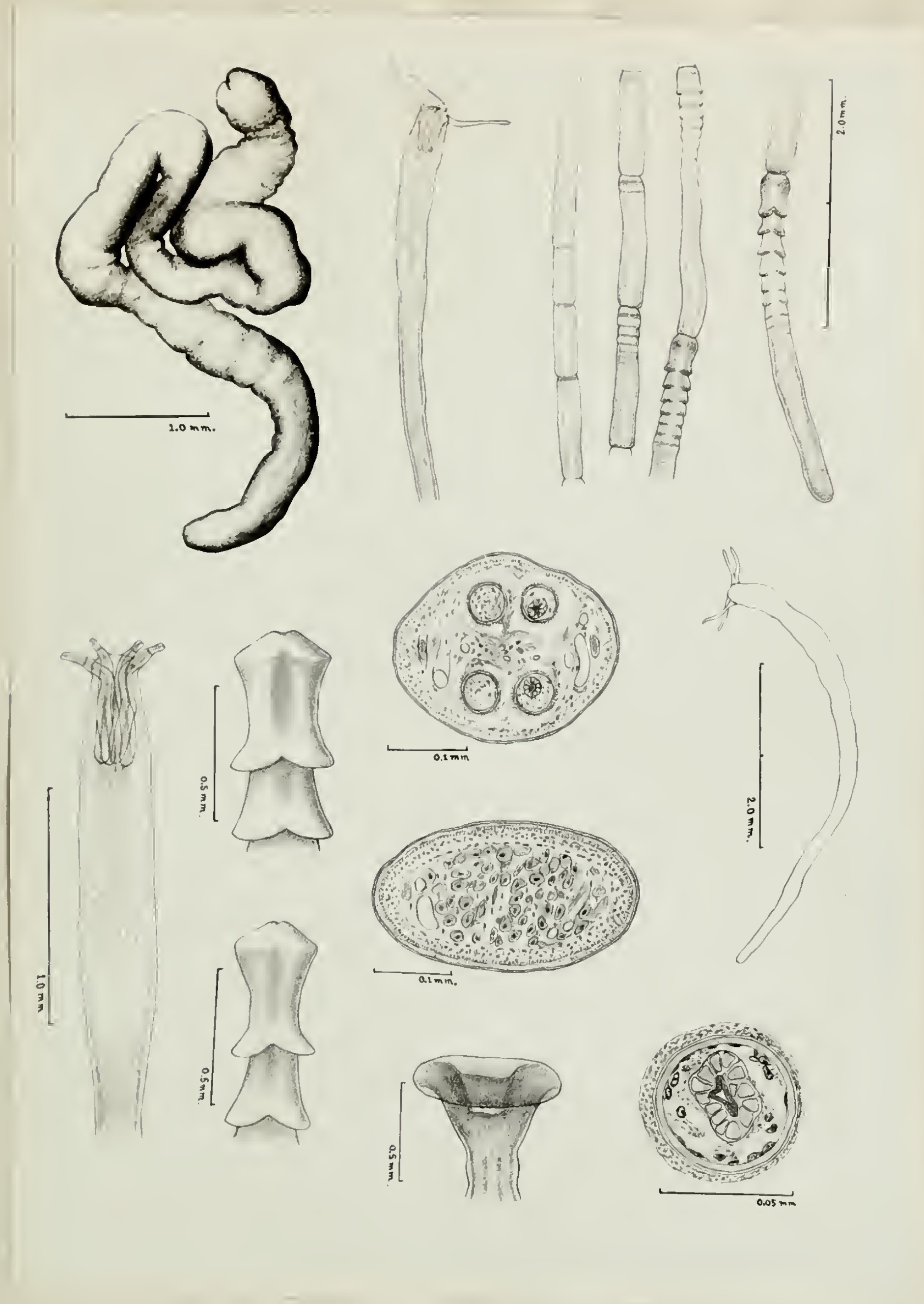

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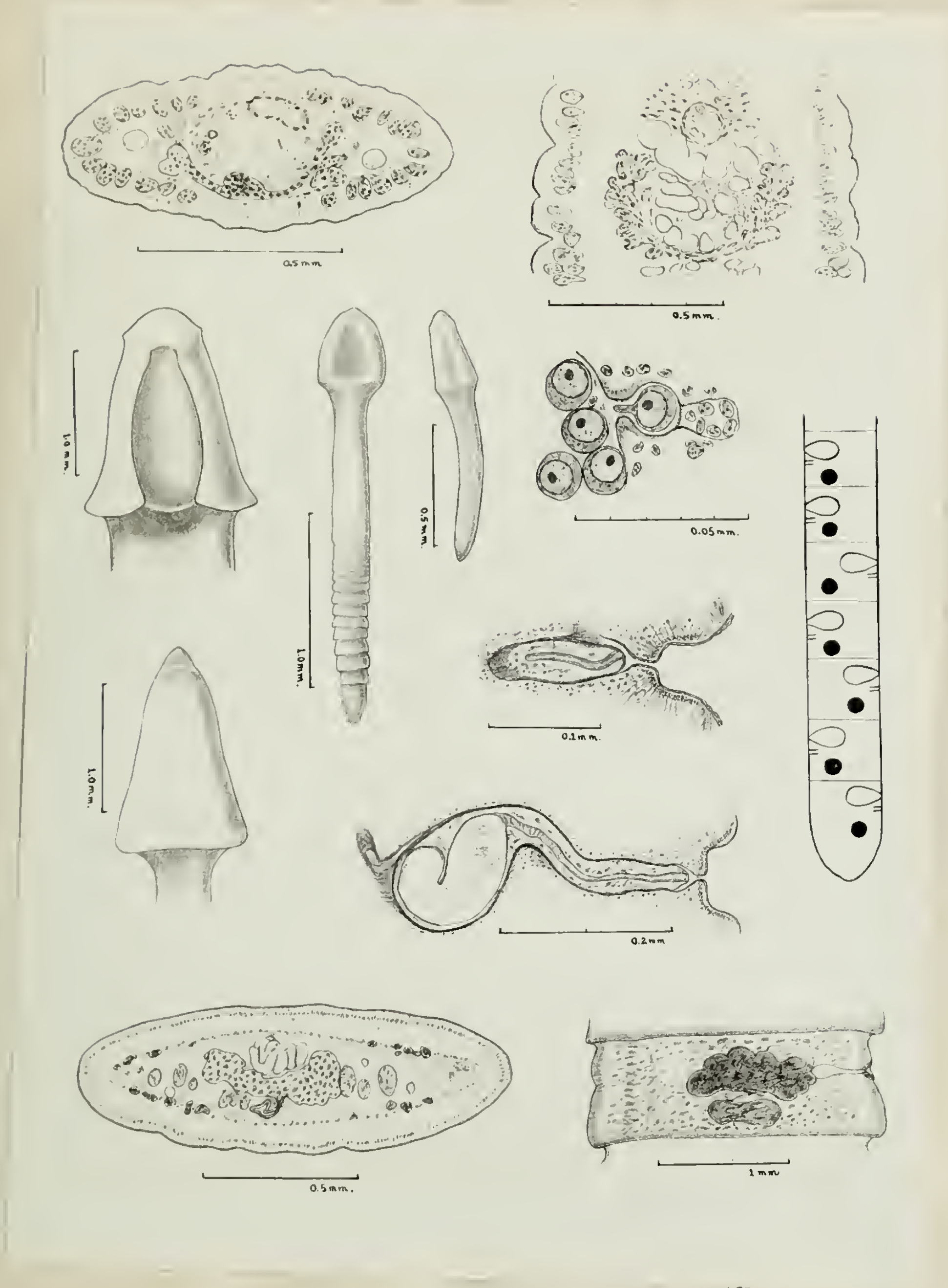

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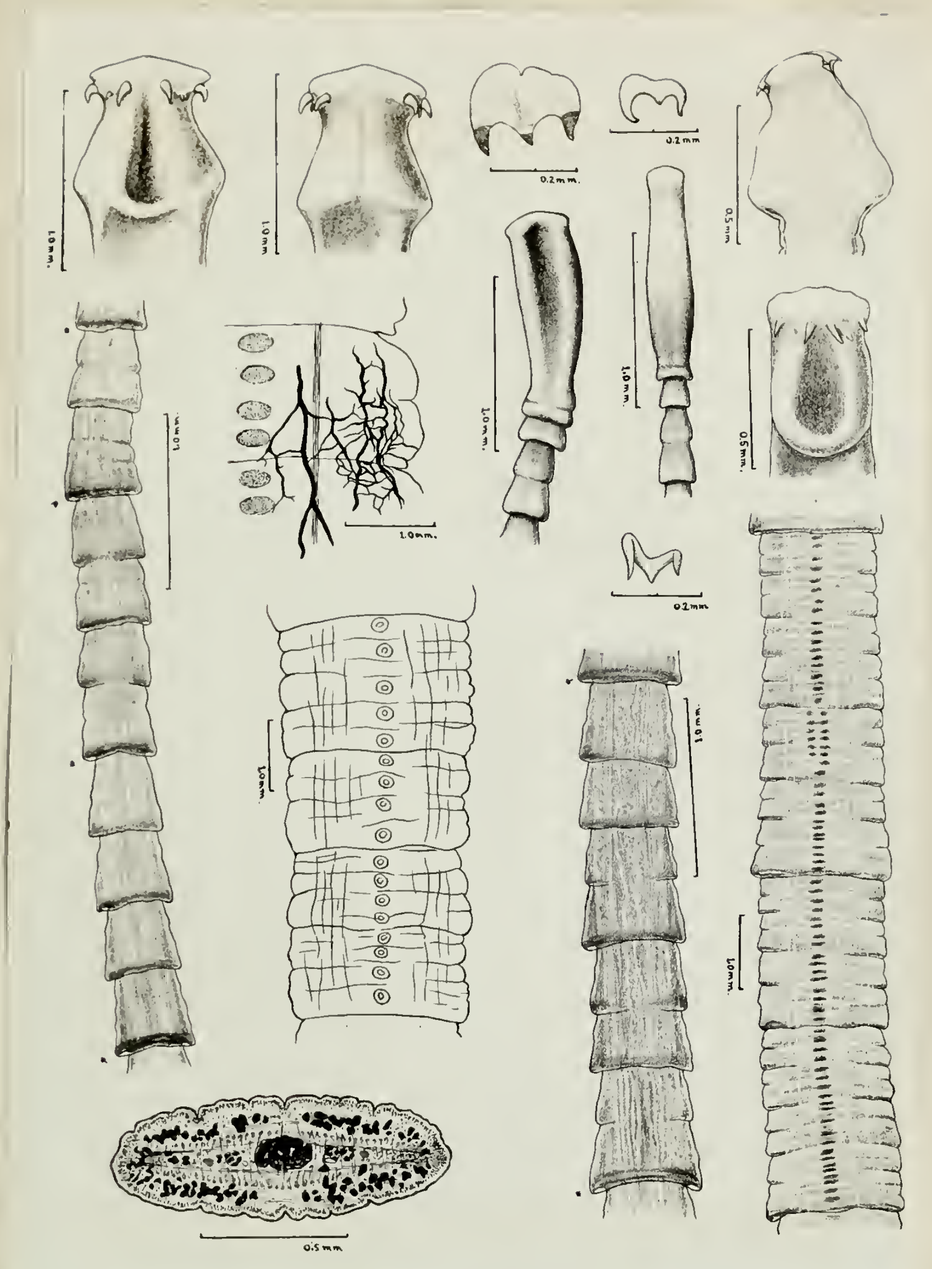

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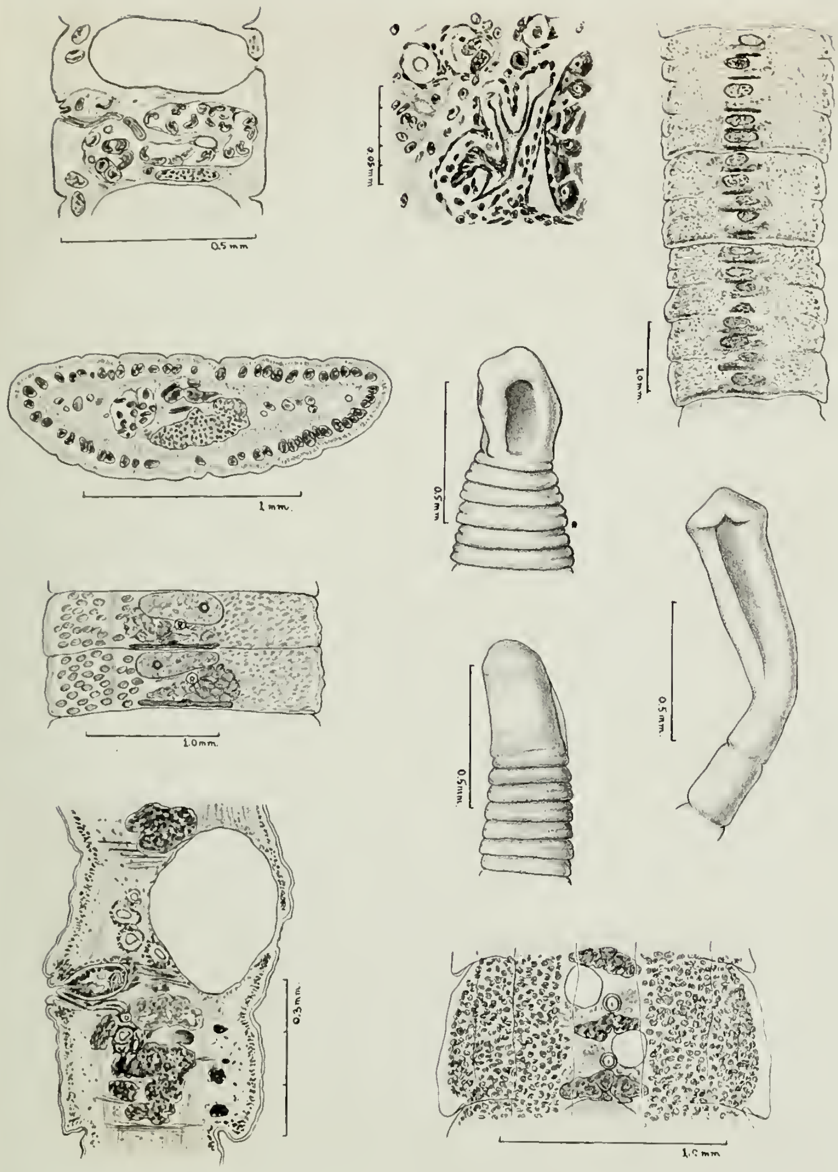

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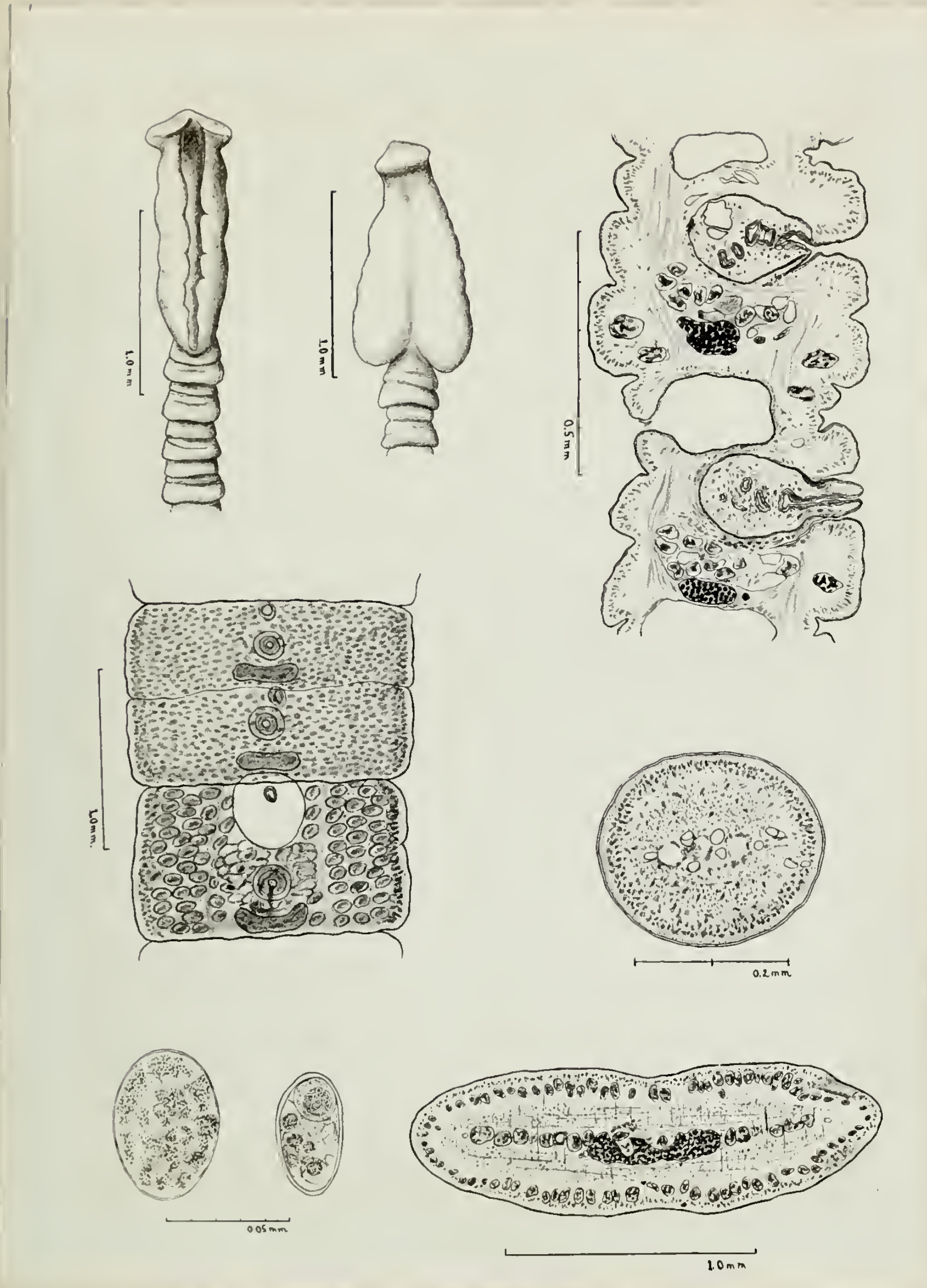

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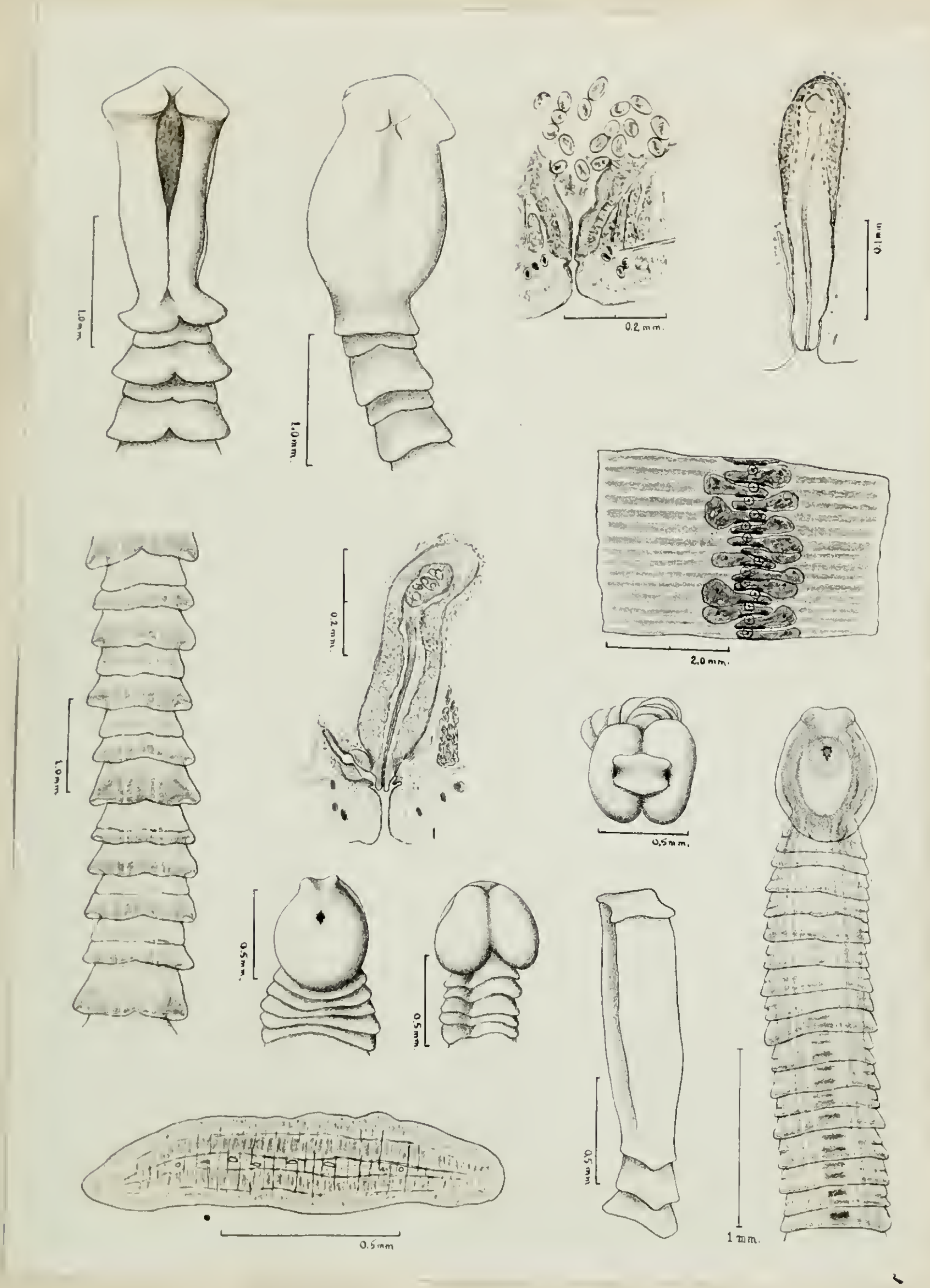
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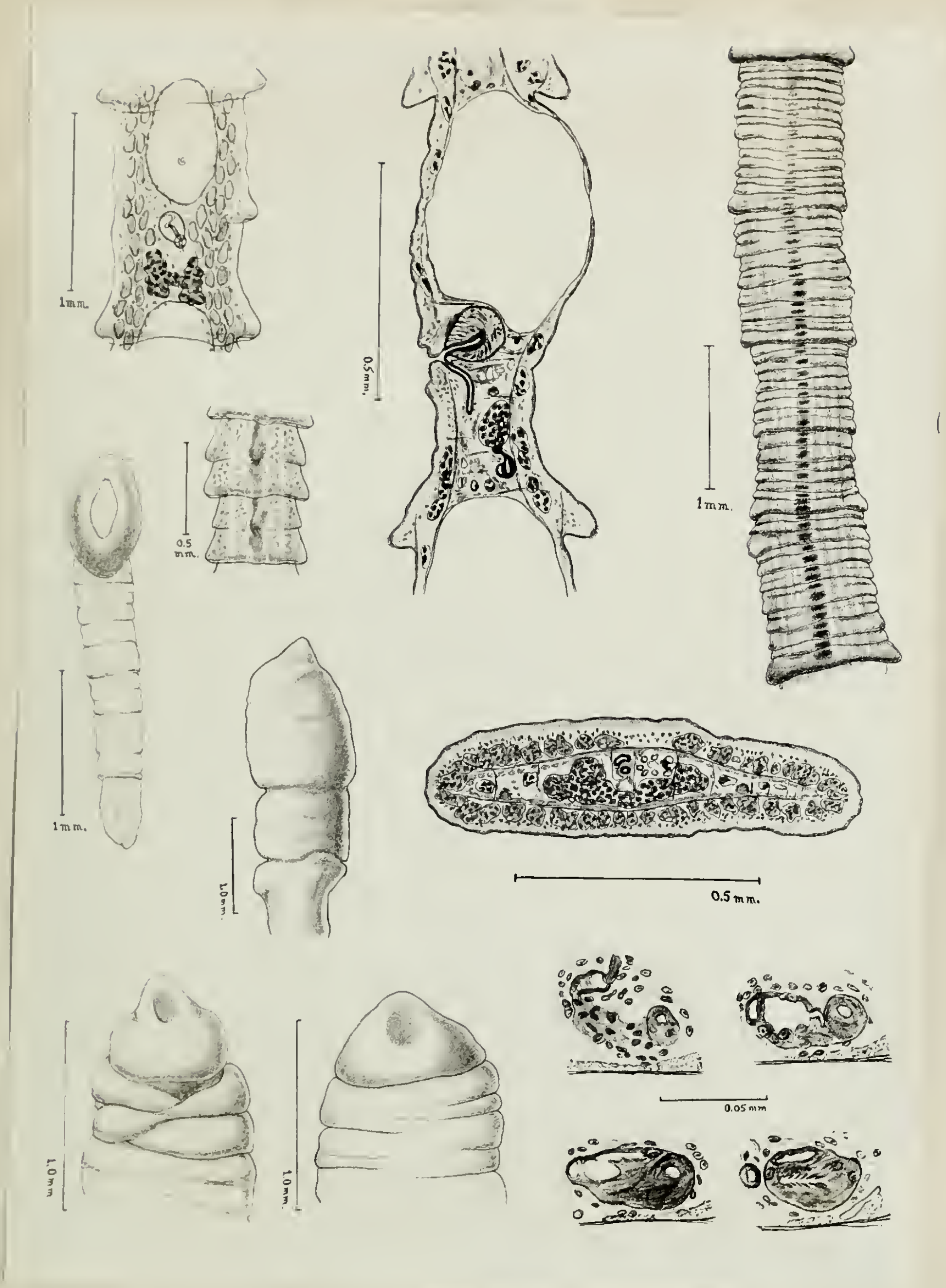

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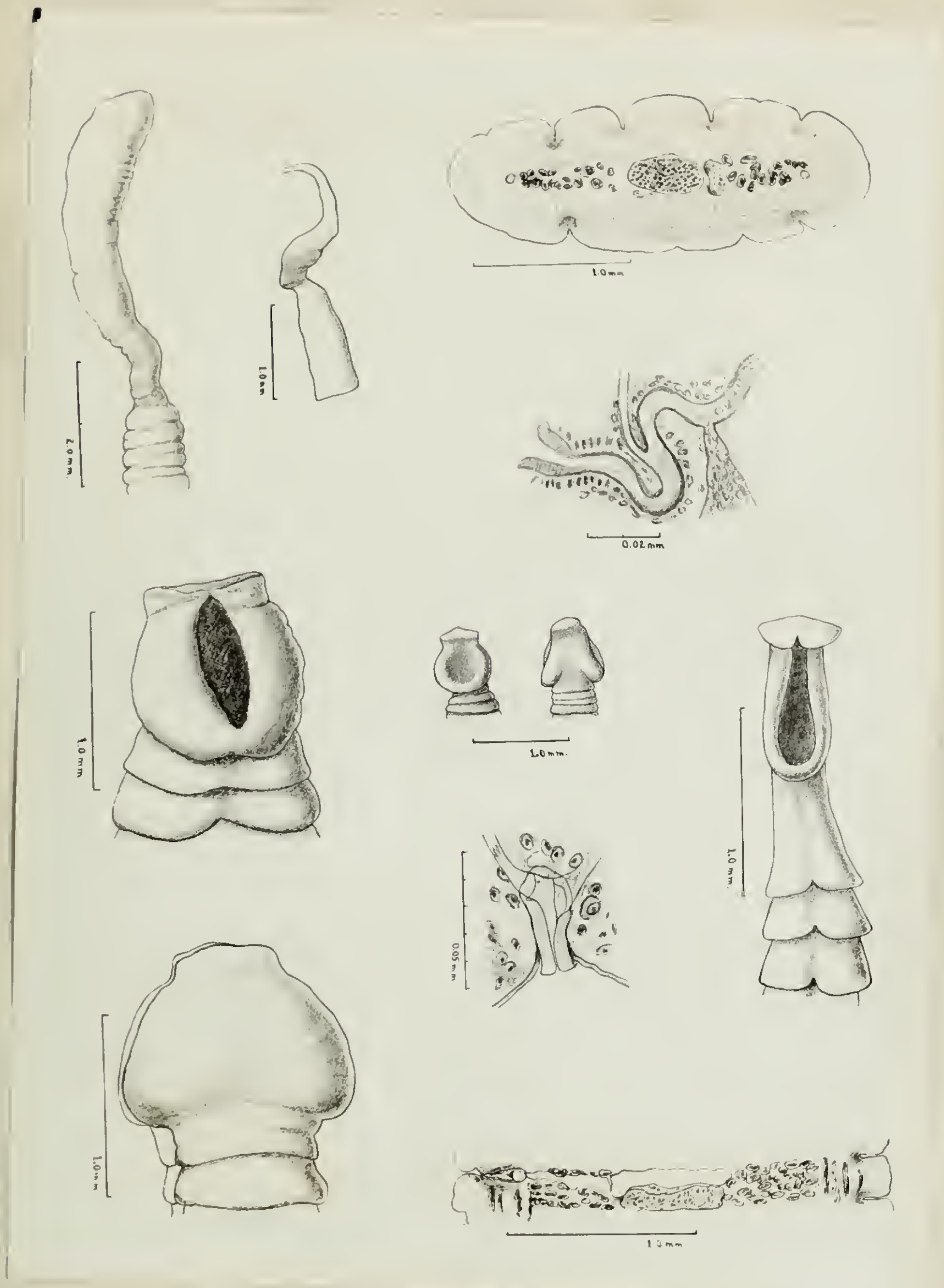
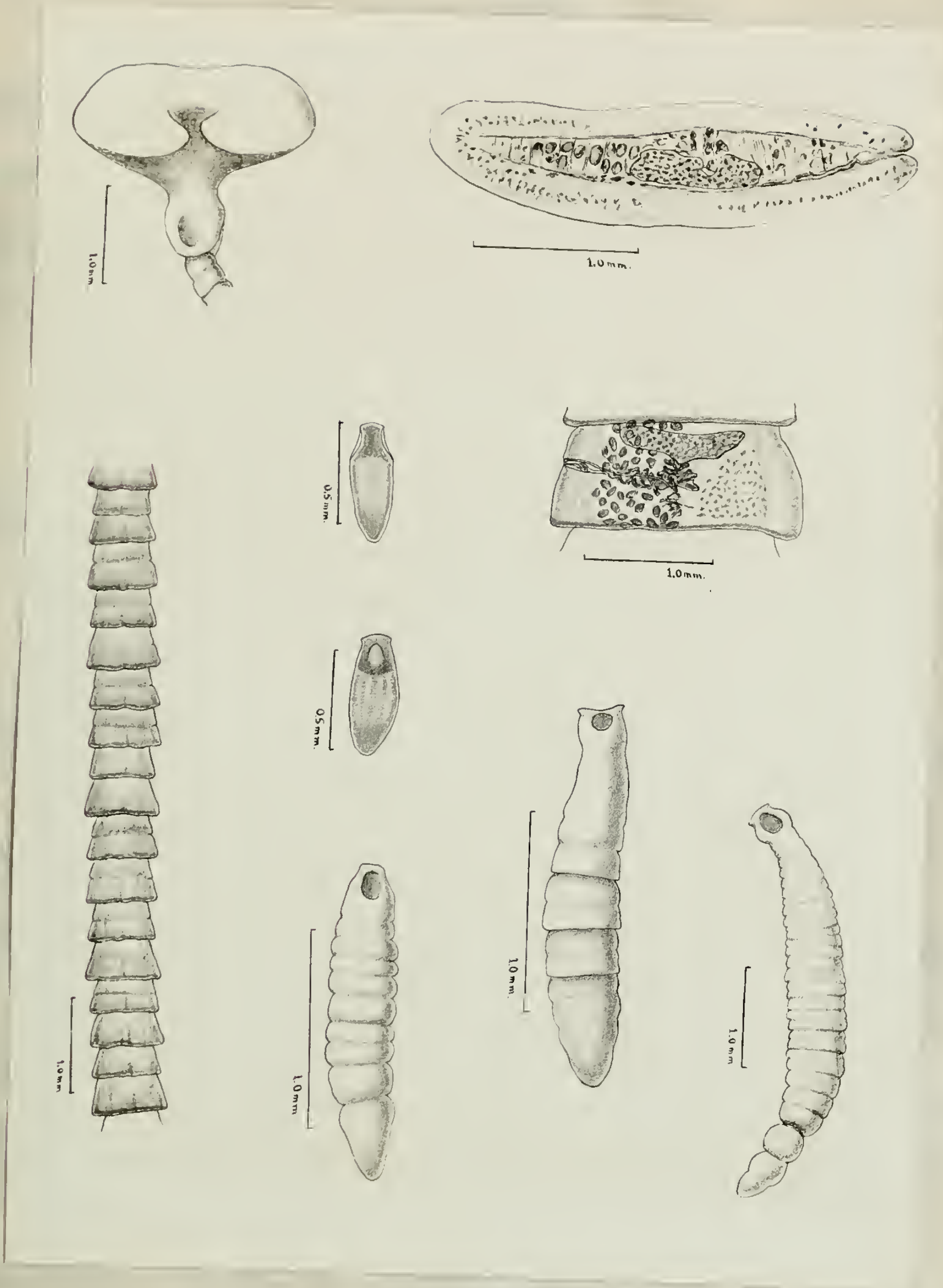


PLATE X.



VITA.

Arthur Reuben Cooper.

1888........ Born at Brinston, Ontario, Canada, October 30.

1896-1901... Attended the local public school.

1901-1906... Attended Iroquois High School, Iroquois, Ontario.

1906........ Entered the University of Toronto with the Seventh Edward Blake Scholarship in General Proficiency at the Honor Matriculation Examinations.

1906-1910... Pursued the honor course in Biology in Victoria College, obtaining the Gold Medal in "The Science of Biology".

1910........ Obtained the degree of Bachelor of Arts from Victoria College, University of Toronto.

1909-1911... Class assistant in general Biology.

1911........ Obtained the degree of Master of Arts with "Honors" from University College, University of Toronto.

1911-1912... Demonstrator in zoology, University College.

1909-1912... Four summers at the Lake Biological Station on Georgian Bay, Go-Home Bay, Ontario.

1912-1914... Fellow in Zoology, University of Toronto.

1913-1914... Two summers at the Marine Biological Station at Saint Andrews, New Brunswick.

1914-1915... Demonstrator in Zoology, University of Toronto.

1915-1916... Fellow in Zoology in the University of Illinois.

1916........ Summer at Marine Biological Laboratory at Woods Hole, Mass. and Harpswell Laboratory, South Harpswell, Me.

1916........ Elected to the Illinois Chapter of the Society of Sigma Xi and to the American Microscopical Society.

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Publications:

(1) On the Systematic Position of _Haplobothrium globuliforme_ Cooper. Trans. Roy. Soc. Can., Series III, VIII, Sect.1: 1-5. 1914.

(2) A New Cestode from _Amia calva_ L. Trans. Roy. Can. Inst 10(2) :81-119. 3 pls. 1914.

(3) Contributions to the Life-History of _Proteocephalus ambloplitis_. A Parasite of the Black Bass. Contrb. to Can. Biol., 47th Rep. Dept. Fisheries, Ottawa, Canada, Fasc. II :177-194. 3 pls. 1915.

(4) Trematodes from Marine and Fresh-Water Fishes, including one Species of Ectoparasitic Turbellarian. Trans. Roy. Soc. Can., Series III, IX :181-205, 3 pls. 1915.

(5) Notes on _Porocephalus globicephalus_. In conjunction with Thesle T. Job. Journ. Parasitology, 3(3) :138.